CAVE HUNTING.

Fig. 2.

Fig. 3.

Fig. 1.

Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7.

Fig. 8.

C F Kell Lith London E.C.

ENAMELS FROM THE VICTORIA CAVE p95.

London Macmillan & Co 1874

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NTING.

CAVE HUNTING,

RESEARCHES ON

THE EVIDENCE OF CAVES

RESPECTING THE

EARLY INHABITANTS OF EUROPE

BY

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TO

THE BARONESS BURDETT COUTTS,

THE FOUNDER OF THE SCHOLARSHIPS

FOR THE ENCOURAGEMENT OF GEOLOGICAL SCIENCE

IN THE UNIVERSITY OF OXFORD,

This Work is Dedicated,

AS A SLIGHT ACKNOWLEDGMENT FROM HER FIRST SCHOLAR.

PREFACE.

THE exploration of caves is rapidly becoming an important field of inquiry, and their contributions to our knowledge of the early history of the sojourn of men in Europe are daily increasing in value and in number. Since the year 1823, when Dr. Buckland published his famous work, the "Reliquiæ Diluvianæ," no attempt has been made to correlate, and bring into the compass of one work, the crude mass of facts which have been recorded in nearly every country in Europe. In this volume I have attempted to bring the history of cave-exploration down to the knowledge of to-day, and to put its main conclusions before my readers in one connected and continuous narrative. Since Dr. Buckland wrote, the momentous discovery of human relics along with the extinct animals in caves and river deposits has revolutionised the current ideas as to the antiquity and condition of man; and works of art of a high order, showing a familiarity with nature and an aptitude for the delineation of the forms of animals by no means despicable, have been discovered in the caves of Britain, France, Belgium, and Switzerland, that were the dwellings of the primeval European hunters of reindeer and mammoths. The discoveries in Kent's Hole and in the caves of Belgium led to those in the caves of Brixham and Wookey Hole,

and finally to those of Auvergne and the south of France, as well as of Germany and Switzerland.

Archæology, also, by the use of strictly inductive methods, has grown from a mere antiquarian speculation into a science; and its students have proved the truth of the three divisions of human progress familiar to the Greek and Roman philosopher, and expressed in the pages of Hesiod and Lucretius—the Ages of Stone, Bronze and Iron. The subdivision of the first of these into the older, or palæolithic, and newer, or neolithic, by Sir John Lubbock, is the only refinement which has been made in this classification. Sir Charles Lyell has discussed the various problems offered by the general consideration of the first of these divisions in "The Antiquity of Man;" while Sir John Lubbock, in "Prehistoric Man," has followed Dr. Keller and others in working out the past history of mankind by a comparison of the habitations, tombs, implements and weapons found in Europe, with those of modern savages. This work is intended to be to a considerable extent supplementary to theirs,—to treat of the formation of caves, and of the light thrown by their contents on the sojourn of man in Europe, on the wild animals, and on the changes in climate and geography.

In treating of the caves of the historic period, I have given considerable prominence to the exploration of the Victoria Cave, near Settle, which has led to the discovery that many caverns were inhabited in this country during the fifth and sixth centuries, and that they contain works of art of a high order. In the difficult task of bringing them into relation with British history and art, I have to acknowledge the kind assistance of Mr. E. A. Freeman, the Rev. J. R. Green, and Mr. A. W. Franks.

In the neolithic division of the prehistoric period, I have published at length my recent discoveries in the sepulchral caves of Denbighshire, and am allowed by my friend, Professor Busk, to reprint his description of the human bones. To his suggestive essay on the Gibraltar caves, as well as to the works of the late Dr. Thurnam, and of Professors Broca and Huxley, I am indebted for the clue to the identification of the neolithic dwellers in caves with the ancient Iberians or Modern Basques. That portion of the evidence which relates to France I have verified by a personal examination of the human remains from caves and tombs in the Museums of Bordeaux, Toulouse, Lyons and Paris.

The results of the exploration of the Hyæna-den of Wookey Hole have been given in greater detail in the portion of the work devoted to the palæolithic age than they would have been, had they been before fully recorded. And in this division of the subject I have largely made use of the "Reliquiæ Aquitanicæ," which embodies the discoveries in Auvergne of my late friends Professor E. Lartet and Mr. Christy. To the editors of that work I am indebted for permission to use some of the plates and letterpress.

The history of the pleistocene mammalia, in which palæolithic man forms the central figure, has been my especial study for many years. And the evidence which is offered by the animals as to the geography and climate of Europe, which I have published from time to time in the works of the Palæontographical Society, the *Geological Journal*, and in the *Popular Science*, *British Quarterly*, and *Edinburgh Reviews*, is collected together in this work, and brought into relation with the inquiry into the extension of ice over Europe in the glacial

period, and into the soundings of the European seas. In approaching these and the like problems, I have done my best to arrive at the truth by visiting as far as possible the foreign localities and collections, and by correspondence with the discoverers of new facts.

In addition to those names which I have already mentioned, I have to express my thanks to the Councils of the Society of Antiquaries, the Geological Society, and of the Anthropological Institute and to Mr. John Evans, for the use of woodcuts; to Mr. Rooke Pennington for looking over some of the proof sheets; and to Professors Gaudry, Rütimeyer, Lortet, Nilsson, and Steenstrüp, and the Rev. Canon Greenwell for aid of various kinds. But especially do I feel grateful to my old friend and master, the late lamented Professor Phillips, for frequent help and prudent counsel.

In laying this book before my readers I would merely further remark, that it is a faint outline of a new and vast field of research, in which I have attempted to give prominence to the more important points, rather than a finished and detailed history of cave-exploration.

W. B. D.

THE OWENS COLLEGE, MANCHESTER,
20th July, 1874.

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ADDITIONS AND CORRECTIONS.

Page 1, line 7, *for* "Cythæron" *read* "Cithæron."

Page 8, line 4, *for* "that" *read* "who."

Page 17, line 5, *for* "Seine" *read* "Somme."

Page 60, lines 29, 30, *for* "non-ossiferous" *read* "no ossiferous."

Page 82, fig. 19, *for* "A, B, Albert, C, Victoria" *read* "A, B, Victoria, C, Albert."

Page 95, fig. 25.—This design is to be seen in the chalice discovered in 1868, in a rath at Ardagh, Limerick, and described by the Earl of Dunraven (Trans. Royal Irish Acad. xxiv. Antiquities). The chalice is made of gold, silver, bronze, brass, copper, and lead, and from the identity of its inscription and ornament with those of Irish MSS. of ascertained age, may be referred to a date ranging from the 5th to the 9th centuries. It is also adorned with squares of blue and red enamel of the same kind as that of the brooches from the Victoria Cave, figured in the coloured plate. The same design is also presented by the "bronze head-ring" found in 1747 at Stitchel, in Roxburgh, (Wilson "Prehistoric Annals of Scotland," ii. 146) as well as by one of the silver articles known as "The Norrie Law Relics," found in a tumulus on the shore of the Bay of Largo, Firth of Forth. Of the coins found at the same place, the latest, belonging to Tiberius Constantine (d. 682), fixes the date as not earlier than the 7th century. Some of the sculptured stones of Scotland, such as the Dunnichen stone, are ornamented also in the same style, and, according to Professor Wilson, belong to "the transition period from the 4th to the 8th centuries, when pagan and Christian rites were obscurely mingled," (ii. 259). In Scotland, therefore, as well as Ireland, this style of ornamentation is of the same age, corresponding in the main with that of Brit-Welsh articles in the Victoria Cave, proved by the associated coins to be later than the 4th century.

Page 120, line 4.—These teeth are considered by Dr. Leith Adams to belong to *Elephas antiquus*, which has been discovered in other places in Yorkshire. They may possibly belong to that animal; but they may, with equal justice, be identified with the wide-plated variety of the teeth of the Mammoth. The great variation in the width of the component plates of the fossil teeth of Mammoth observable in the large series from Crayford and the caves of the Mendip Hills, and in those in the magnificent Museum of Lyons, causes me to hesitate in considering them to belong to the rarer species.

Page 130, line 2.—This has been verified while these sheets were passing through the press by the discovery of Brit-Welsh articles in a cave in Kirkcudbrightshire by Messrs. A. R. Hunt and A. J. Corrie, among which are bone fasteners similar in outline to that from the Victoria Cave (Fig. 23).

Page 190.—In using this classification of crania, I have purposely attached higher value to the two extremes of skull form, or the long and the broad, than to the intermediate oval forms, which cannot be viewed as distinctive of race, because they may be the results either of the intermarriage of a long-headed with a short-headed people, or of variation from the type of one or other of them.

Page 196, heading, *for* "Dolicho-cepha" *read* "Dolicho-cephali."

Page 201, heading, *dele* "A".

Page 213, note 2.—The "tête annulaire," or annular depression, is also visible on some of the broad as well as the long skulls from a "Merovingian" cemetery at Chelles in the same collection. The association in this cemetery of the two skull-forms is probably due to the Merovingians being the masters, and the Celts the servants, and the conquerors and the vanquished being buried in the same spot.

Page 220, line 24, *for* "Volscæ" *read* "Volcæ."

Page 223, line 25, *for* "east" *read* "west."

Page 228, line 3, *dele* "that."

Page 229, line 3, *for* "set foot" *read* "settled." The statement in the text is too strong. The conquest of Gaul by the Huns under Attila was averted by his defeat in the famous battle of Chalons.

Page 275, line 21, *for* "are" *read* "is."

Page 279.—Since this was written a new ossiferous deposit has been found in a fissure at Lothorsdale, near Skipton, from which the remains of the *Elephas antiquus* and *Hippopotamus amphibius* have been obtained.

Page 284.—The ossiferous fissure at Windy Knoll, near Castleton, recently explored by Messrs. Tym, Pennington, Plant, Walker and others, has added several animals to the pleistocene fauna of that district—the bison, roe, reindeer, bear, wolf, fox, and hyæna, the first of these species being remarkably abundant, and of all ages. The remains were probably introduced by a stream from a higher level.

Page 337, note 2, line 2, *for* "the Revue" and "les Matériaux" *read* "in the Revue" and "in the Matériaux."

Page 337, note 5, *for* "Aquitainicæ" *read* "Aquitanicæ."

Page 347, line 6, *for* "mind" *read* "minds."

Page 356, line 15, *for* "Port" *read* "Fort."

Page 361.—Mr. Ayshford Sanford adds the *Felis Caffer* to the list from Bleadon, and the *Gulo borealis* to that of the animals from Kent's Hole.

Page 386, line 10, *dele* inverted commas.

Page 386, line 17, *for* "or from 1,000 to 2,000 feet lower than the glacial covering" *read* "thus differing by a line of from 1,000 to 2,000 feet from the glacial covering" (Palgrave).

CAVE-HUNTING.

CHAPTER I.

INTRODUCTION.

Legends and Superstitions connected with Caves.—The Physica Division of the Subject.—The Biological.—The Inhabitants of Caves.—Men and Animals.—Ethnological, Archæological, and Geographical Bearings.—The three Classes of Bone-Caves : Historic, Prehistoric, Pleistocene.—History of Cave Exploration in Europe : Germany, Great Britain, France, Belgium, Southern Europe.

Caves have excited the awe and wonder of mankind in all ages, and have figured largely in many legends and superstitions. In the Roman Mythology, they were the abode of the Sibyls, and of the nymphs, and in Greece they were the places where Pan, Bacchus, Pluto, and the Moon were worshipped, and where the oracles were delivered, as at Delphi, Corinth, and Mount Cythæron ; in Persia they were connected with the obscure worship of Mithras. Their names, in many cases, are survivals of the superstitious ideas of antiquity. In France and Germany they are frequently termed "Fairy, Dragons', or Devils' Caves," and, according to M. Desnoyers, they are mentioned in the invocation of certain canonized

anchorites, who dwelt in them after having dispossessed and destroyed the dragons and serpents, the pagan superstition appearing in a Christian dress.

In the Middle Ages they were looked upon as the swellings of evil spirits, into the unfathomable abysses of which the intruder was lured to his own destruction. Long after the fairies and little men had forsaken the forests and glens of Northern Germany, they dwelt in their palaces deep in the hearts of the mountains, —in "the dwarf holes," as they were called—whence they came, from time to time, into the upper air. Near Elbingrode, for example, in the Hartz, the legend was current in the middle of the last century, that when a wedding-dinner was being prepared the near relations of the bride and bridegroom went to the caves, and asked the dwarfs for copper and brass kettles, pewter dishes and plates, and other kitchen utensils.[1] "Then they retired a little, and when they came back, found everything they desired set ready for them at the mouth of the cave. When the wedding was over they returned what they had borrowed, and in token of gratitude, offered some meat to their benefactors." Allusions, such as this, to dwarfs, according to Professor Nilsson, point back to the remote time when a small primeval race, inhabiting Northern Germany, was driven by invaders to take refuge in caverns,—a view that derives support from the fact that in Scandinavia the tall Northmen were accustomed to consider the smaller Lapps and Finns as dwarfs, and to invest them with magic power, just as in Palestine the smaller invading

[1] The Natural History of the Hartz Forest (Hercynia Curiosa). translated from the German of H. Behrens, M.D., by John Andree, 1670, p. 41.

peoples considered their tall enemies giants. The cave of Bauman's hole, also in the Hartz district, was said, in the middle of the last century, to have been haunted by divers apparitions, and to contain a treasure guarded by black mastiffs; and in Burrington Combe, in Somersetshire, some twenty years ago, a cave was dug out by a working man, under the impression that it contained gold. The hills of Granada are still believed, by the Moorish children, to contain the great Boabdil and his sleeping host, who will awake when an adventurous mortal invades their repose, and will issue forth to restore the glory of the Moorish kings.

It is, indeed, no wonder that legends and poetical fancies such as these should cluster round caves, for the gloom of their recesses, and the shrill drip of the water from the roof, or the roar of the subterranean water-falls echoing through the passages, and the white bosses of stalagmite looming like statues through the darkness, offer ample materials for the use of a vivid imagination. The fact that often their length was unknown, naturally led to the inference that they were passages into another world. And this is equally true of the story of Boabdil, of that of the Purgatory of St. Patrick, in the north of Ireland, and of the course of the river Styx, which sinks into the rocks and flows through a series of caverns that are the dark entrance-halls of Hades. The same idea is evident in the remarkable story, related by Ælian (Lib. xvi. 16). "Among the Indians of Areia there is an abyss sacred to Pluto, and beneath it vast galleries, and hidden passages and depths, that have never been fathomed. How these are formed the Indians tell not, nor shall I attempt to relate. The Indians drive thither (every year) more

than 3,000 different animals—sheep, goats, oxen, and horses—and each acting either from dread of the dreadful abyss, or to avert an evil omen in proportion to his means, seeks his own and his family's safety by causing the animals to tumble in; and these, neither bound with chains nor driven, of their own accord finish their journey as if led on by some charm; and after they have come to the mouth of the abyss they willingly leap down, and are never more seen by mortal eyes. The lowing, however, of the cattle, the bleating of the sheep and of the goats, and the whinnying of the horses are heard above ground, and if anyone listen at the mouth, he will hear sounds of this kind lasting for a long time. Nor do they ever cease, because beasts are driven thither every day. But whether the sound is made by those recently driven in, or by some of those driven in some time before, I do not express an opinion." The Roman Catholic Church took advantage of this feeling of superstitious awe, as late as the Middle Ages. At the time of the Reformation it was believed that a cave at Bishofferode would prove the death of some person in the course of the year, unless a public yearly atonement were made. Accordingly a priest came, on a certain day, to the chapel on the hill opposite, whence he passed in solemn procession to the cave, "and let down into it a crucifix, which he pulled up again, and took this occasion to remind them of hell, and to avoid the punishment due to their sins."

The beauty of the interiors of some of the caves could not fail to give rise to more graceful fancies than these. The fantastic shapes of the dripstone, with which they are adorned, now resembling Gothic pillars supporting a crystalline arcade, or jutting out

in little spires and minarets, and very generally covering the floor with a marble-like pavement, and in some cases lining the pools of water with a fretwork of crystals that shine like the facets of a diamond, were fitting ornaments for the houses of unearthly beings, such as fairies.

The Physical Division of the Subject.

It is by no means my intention in this work to give a history of legends such as these, but to take my readers with me into some of the more important and more beautiful caves in this country. The exploration of the chambers and passages of which they are composed, the fording of the subterranean streams by which they are frequently traversed, or the descent into deep chasms which open in their floors, have the peculiar charm of mountaineering, not without a certain pleasurable amount of risk. But to physicist and geologist they offer far more than this. They give an insight into the wonderful chemistry by which changes are being wrought, at the present time, in the solid rock. Nor are the conclusions to which we are led by the investigation of these chemical changes merely confined to the interior of caves. They enable us to understand how some of the most beautiful scenery in Europe has been formed, and to realize the mode by which all precipices and gorges have been carved out of the calcareous rock. In the next chapter we shall see why it is that the combination of hill and valley, ravine and precipice, present the same general features in all limestone districts—why, for instance, the ravines of Palestine are the same as those of Greece, and both are

identical with those in Yorkshire. The origin and the history of caves will be examined, as well as their relation to the general physical geography of the calcareous strata. All these subjects are comprehended in the first or the physical division of cave-hunting.

The Biological Division.

We must now proceed to the definition of the scope and object of the second, or Biological, division of the subject.

Caves have been used by man, and the domestic animals living under his protection, from the earliest times recorded by history down to the present day. Those penetrating the rugged precipices of Palestine, we read in the Old Testament, served both for habitation and for burial, and, from the notices which are scattered through the early Greek writers, we may conclude that those of Greece were used for dwelling-places. The story of the Cyclops proves that they were also used as folds for goats. The name of Troglodytes, given to many peoples of the most remote antiquity, implies that there was a time in the history of mankind when Pliny's statement "specus erat pro domibus" was strictly true ("Hist. Nat." I. v. c. 56). The caves of Africa have been places of retreat from the remotest antiquity down to the French conquest of Algeria, and in 1845 several hundred Arabs were suffocated in those of Dahra by the smoke of a fire kindled at the entrance by Marshal (then Colonel) Pelissier. Dr. Livingstone alludes in his recent letters to the vast caves of Central Africa, which offer refuge to whole tribes with their cattle and household stuff. In France, according to M.

Desnoyers, there are at the present time whole villages, including the church, to be found in the rock, which are merely caves modified, extended, and altered by the hand of man. The caves of the Dordogne were inhabited in the middle ages. Florus writes that the Aquitani, "callidum genus in speluncas se recipiebant, Cæsar jussit includi,"[1] and the same caves afforded shelter to the inhabitants of the same region in the wars of King Pepin against the last Duke of Aquitaine. In this country a small cave in Cheddar Pass was occupied till within the last few years. The caves in the northern counties are stated by Gildas to have offered a refuge to the Brit-Welsh inhabitants of Britain during the raids of the Picts and Scots; and in the year 1745 those of Yorkshire were turned to the same purpose during the invasion of the Pretender. We might reasonably expect to find in caves turned to these uses objects left behind, which would tell us something of the manners and customs of their possessors, and light up the catalogue of battles and intrigues of which history generally consists. The results obtained from the Brit-Welsh group of caves, treated in the third chapter, show that this hitherto neglected branch of the inquiry is not without value to the historian.

Caves containing remains of this kind may be conveniently termed historic, because they may be brought into relation with history. It must, however, be carefully remarked that the term does not relate to history *in general*, but to that *in particular* of each country which happens to be under investigation. The misapprehension of this has caused great confusion, and many mistakes in archæological classification and reasoning.

[1] Florus, lib. iii. c. x. Delphin. 4to. 1714, p. 112.

Again, our experience of the habits of rude and uncivilized peoples would naturally lead us to look to caves, as the places in which we should be likely to meet with the remains of the men that lived in Europe before the dawn of history. Such remains we do find that, placed side by side with others from the tombs and dwellings, enable us to discover some, at least, of the races who lived in Europe in long-forgotten times, and to ascertain roughly the sequence of events in the remote past, far away from the historical border. It may, indeed, seem a hopeless quest to recover what has been buried in oblivion so long, and it is successful merely through the careful comparison of the human skeletons in the caves and tombs of Britain, France, and Spain, with those of existing races, and of the implements and weapons with those which are now used among savage tribes. By this means we shall see that there are good grounds for extending the range of the Iberian people over a considerable area in Europe, and for the belief that the Eskimos once lived as far south as Auvergne. In discussing both these problems it will be impossible to shut our eyes to the continuity that exists between geology, archæology, biology, and history—sciences which at first sight appear isolated from each other.

The bones of the domestic animals in the caves will necessarily lead to the further examination of the appearance and disappearance of breeds under the care of man. And this complicated question has an important bearing not merely on the ethnology, but also on the history, of some of the European peoples. It must be admitted, however, that this branch of the subject is, as yet, known merely in outline, and we can only hope to ascertain a few facts which may form a basis for future investigation.

From another point of view the contents of caves are peculiarly valuable. They have been used as places of shelter, not merely by man, but by wild animals, from the time they first became accessible to the present day. In the same way, therefore, as now they contain, in their superficial layers, the bones of sheep, oxen, and horses, foxes, rabbits, and badgers, so in their deeper strata lie buried the remains of the animals which were living in Europe long before the historic times. In other words, they enable us to make out the groups of animals inhabiting the neighbouring districts, and which in many cases have either forsaken their original abodes or have become extinct. And since those which are extinct, or which have migrated, could not have lived where their remains are found under the present conditions of life, an inquiry into their history leads us into the general question of the ancient European climate and geography. It is obvious, for example, that the spotted hyæna, which formerly inhabited the caves of Sicily, could not have crossed over to that island after it was separated from Africa and Italy; and it would be impossible for the musk-sheep, the most arctic of the herbivora, to live as far south as Auvergne under the present climatal conditions. The presence, therefore, of these animals in these districts is proof in the one case of a geographical, and in the other of a climatal, change.

The discussion of all these questions is comprehended under the second, or biological, division of cave-hunting, which may be defined as an inquiry into the remains of man and animals found in the caves, and into the conditions under which they lived in Europe.

The three Classes of Bone-caves.

In the biological branch of the subject the caves will be treated first which are comprehended within the limits of history; then we shall pass on to the investigation of Prehistoric caves, or those which have been inhabited in the interval that separates history from the remote geological era, which is characterized by the existence of the extinct mammalia in Europe. And, lastly, those will be examined which have furnished the remains of the extinct animals, and which are termed by the geologists Pleistocene, from the fact that a larger percentage of existing species were then living than in the preceding Pleio-, Meio-, and Eocene periods. The equivalent terms "Quaternary," used by many French geologists, and the "Post-pleiocene division of the Post-tertiary Formation," used by Sir Charles Lyell, are not adopted in this work, because they imply a break in the continuity of life, which does not exist. "Pleistocene" was invented and subsequently discarded by Sir C. Lyell,[1] and is at present used by many eminent writers, such as Forbes, Phillips, Gervais, and others. The ossiferous caves will therefore be divided into the Historic, Prehistoric, and Pleistocene groups. And it will be more convenient to work backwards in time from the basis offered by history, than to begin with the Pleistocene, or oldest division, and bring the narrative down to the present day.

This classification, founded in part on the principle

[1] Since this was written, Sir C. Lyell has withdrawn his term "Post-pleiocene" in favour of Pleistocene. ("Antiquity of Man," 4th edition, 1873.)

of change in the animal world, and partly on the basis offered by history, coincides, only in part, with that of the archæologists based on the remains of man's handiwork. The Pleistocene age is the equivalent of the Palæolithic, or that of rude unpolished stone; the Prehistoric represents the ages of polished stone, bronze, and iron in part, or those stages in human progress when the use of these materials became general for the purposes of every-day life; while the Historic covers merely the later portion of that of iron.

History of Cave-Exploration in Europe.

Germany.—The rest of this chapter must be devoted to an outline of the history of cave-exploration during the last two centuries. The dread of the supernatural, which preserved the European caves from disturbance, was destroyed in the sixteenth and seventeenth centuries by the search after "ebur fossile," or unicorn's horn, which ranked high in the materia medica of those days as a specific for many diseases, and which was obtained, in great abundance, in the caverns of the Hartz, and in those of Hungary and Franconia. As the true nature of the drug gradually revealed itself, the German caves became famous for the remains of the lions, hyænas, fossil elephants, and other strange animals, which had been used for medicine. We owe the first philosophical discussion on the point to Dr. Gesner,[1] who, although he maintained that the fossil unicorn consisted, in some cases, of elephant's teeth and tusks, and in others of its fossil bones, did not altogether give up the idea of

[1] Hist. Anim. vol. i. Folio, 1603. Article "Monoceias."

its medicinal value. It is a singular fact, that fossil remains of a similar kind are, at the present time, used by the Chinese for the same purpose, and sold in their druggists' shops.[1] The cave which was most famous at the end of the seventeenth century was that of Bauman's Hole, in the Hartz, in the district of Blankenbourg. It is noticed in the Philosophical Transactions for the year 1662, and was subsequently described by Dr. Behrens,[2] Leibnitz, De Luc, and Cuvier, along with others in the neighbourhood. Those of Hungary come next in point of discovery, the first notice of them being due to Patterson Hayne in 1672. They penetrate the southern slopes of the Carpathian ranges, and are known by the name of dragons' caves, because the bones which they contain had been considered from time immemorial to belong to those animals by the country people. These remains were identified by Baron Cuvier as belonging to the cave-bear.[3]

It was not, however, until the close of the eighteenth century that the exploring of caves was carried on systematically, or their contents examined with any scientific precision. The caves of Franconia, in the neighbourhood of Muggendorf, were described by Esper in 1774, by Rosenmuller in 1804, and six years later by Dr. Goldfuss. The most important was that of Gailenreuth, both from the vast quantity of remains which it was proved to contain, and the investigations to which it led. The bones of the hyæna, lion, wolf, fox, glutton, and red

[1] Described by Professor Owen, Quart. Geol. Journ. p. 417. See Hanbury on "Chinese Materia Medica," 1862, 8vo. p. 40. Some of the dragons' teeth were found in caves by Mr. Swinhoe.

[2] Hercynia Curiosa.

[3] See Cuvier, Oss. Foss. vol. iv. pp. 290 et seq.

deer were identified by Baron Cuvier; while some of the skulls which Dr. Goldfuss obtained have been recently proved, by Professor Busk, to belong to the grizzly bear. They were associated with the bones of the reindeer, horse and bison. Rosenmuller was of opinion that the cave had been inhabited by bears for a long series of generations; and he thus realized that these remains proved that the animals found in the cave had once lived in that district, and had not been swept from the tropics by the deluge. The interest in these discoveries was at its height in the year 1816, when Dr. Buckland visited the cave, and acquired that knowledge of cave-exploring which he was subsequently to use with such good effect in this country.[1] From this time down to the present day, no new fact of importance has been added to our knowledge of caves by explorations in Germany.

Great Britain.—The first bone-cave systematically explored in this country was that discovered by Mr. Whidbey,[2] in the Devonian limestone at Oreston, near Plymouth, in 1816; and the remains obtained from it were identified by Sir Everard Home as implying the existence of the rhinoceros in that region. This discovery followed close upon the researches in Gailenreuth, and was due in some degree to the request which Sir Joseph Banks made, that Mr. Whidbey, in quarrying the stone for the Plymouth breakwater, should examine the contents of any caverns that he might happen to meet with. It preceded Dr. Buckland's exploration of Kirkdale by about four years.

1 The references are to be found in Cuvier, top. cit. and in Buckland, "Reliquiæ Diluvianæ," 4to. 1822. Most of them I have verified.

2 Phil. Trans. 1817, p. 176.

In the summer of 1821 a cave was discovered, in a limestone quarry at Kirkdale, in Yorkshire, which was found to contain bones and teeth of animals. On hearing of the discovery, Dr. Buckland posted at once from South Wales to the spot, and published the result of the explorations in the Philosophical Transactions for the next year. He brought forward evidence that the cave had been inhabited by hyænas, and that the broken and gnawed bones of the rhinoceros, mammoth, stag, bison, and horse belonged to animals which had been dragged in for food. He also established the fact that all these animals had lived in Yorkshire in ancient times, and that it was impossible for the carcases of the hyæna, rhinoceros, and mammoth to have been floated from those regions where they are now living into the position where he found their bones. He subsequently followed up the subject by investigating bone-caves in Derbyshire, South Wales, and Somerset, as well as in Germany, and published his great work, "Reliquiæ Diluvianæ," in 1822, which laid the foundations of the new science of cave-hunting in this country. The exploration of Kirkdale followed closely upon that of Gailenreuth, and was merely the application of those principles of research which had been discovered in Germany to caves in a new district.

From this time forward bone-caves were discovered in Great Britain in increasing numbers, and explored by many independent observers. The famous cavern of Kent's Hole, near Torquay, furnished the Rev. J. McEnery, between 1825 and the year 1841, in which he died, with the first flint implements ever discovered in a cave along with the bones of extinct animals. He recognized the fact that they may be proof of the existence of man during the time that those animals were

alive; but the scientific world was not then sufficiently educated to accept the antiquity of the human race on the evidence brought forward, and Dr. Buckland himself was so influenced by the opinions of his times, that he refused even to entertain the idea. Although the discovery was verified by the independent researches of Mr. Godwin Austin in 1840, and by the Torquay Natural History Society in 1846, the force of prejudice was so strong, that the matter was not thought even worthy of investigation. Mr. McEnery's manuscripts were lost until the year 1859, when an abstract of them was published by Mr. Vivian, and subsequently they were printed in full by Mr. Pengelly, the able superintendent of the exploration which has been carried on by a committee of the British Association since 1865, by whom several thousand flint implements have been obtained, under the conditions pointed out by the Rev. J. McEnery and Mr. Godwin Austen.[1]

While the important question of the antiquity of man was being passed by as of no account, other caves were being examined in this country. Those of Banwell, Burrington, Sandford Hill, Bleadon, and Hutton, in the mountain limestone of the Mendip hills, were being worked by the Rev. J. Williams and Mr. Beard, and furnished the magnificent collection of mammalian bones now in the museum at Taunton. In North Wales, also, Mr. Lloyd discovered a similar suite of bones in the limestone caves in the neighbourhood of St. Asaph at Cefn, and in South Wales numerous remains were obtained by many explorers in those of Pembrokeshire and Gower.

[1] Pengelly, "Literature of Kent's Cavern," Devonshire Association. 1868-9. "Kent's Hole," Lecture, delivered in Hulme Town Hall, 1872.

The result of these discoveries was the proof that certain extinct animals, such as the woolly rhinoceros and the mammoth, had lived in this country in ancient times, along with two other groups of species which are at present known only to live in hot and cold climates—the spotted hyæna and hippopotamus of Africa, with the reindeer and the marmot of the colder regions of the earth.

The discovery in 1858, and the exploration, of the now famous cave of Brixham, by the Royal and Geological Societies, marked the dawn of a new era in cave-hunting. Under the careful supervision of Mr. Pengelly, flint implements were discovered underneath stalagmite, and in association with the remains of the hyæna and woolly rhinoceros and mammoth, in undisturbed red loam, under conditions that prove man to have been living in Devonshire at the same time as those animals. This singularly opportune discovery destroyed for ever the doubts that had overhung the question of the antiquity of man, and of his co-existence in Europe in company with the animals whose remains occur both in the caverns and river-deposits.

In 1847 M. Boucher de Perthes described certain rude flint implements that he obtained from the fluviatile gravels of Abbeville ("Antiquités Celtiques," vol. i.), along with the bones of extinct animals; and his discovery was treated with the same scepticism in France as that of the Rev. J. McEnery in England, although it was verified by flint implements being discovered, under exactly the same conditions, in the gravels of Amiens, some forty miles away, by Dr. Rigollot.[1] In the autumn of 1858, Dr. Falconer, who had been superintending the

[1] Comptes Rendus, 1847, pp. 649–50, et 1864, p. 230.

work in the Brixham cave, visited the collection made by M. de Perthes, while on his way to examine the caves of Sicily, and recognizing man's handiwork in the implements, he asked his friend Mr. Prestwich to explore the Valley of the Seine. This he accordingly did, and in company with Mr. John Evans, F.R.S., dug out with his own hands an implement from the undisturbed strata,[1] and thus finally settled the disputed question. It is undoubtedly true, that scientific opinion was tending towards the acceptance of the evidence in favour of man having lived in Europe in the Pleistocene age; but the researches in Brixham cave established the fact on the highest possible authority, and confirmed the long-neglected discoveries in the valley of the Somme. By the end of 1859 it was fully accepted by the scientific world, and caused the exploration of caves to be carried on with increased vigour.

In December 1859,[2] I began the exploration of the hyæna-den of Wookey Hole, near Wells, Somerset, in company with the Rev. J. Williamson, and obtained flint instruments along with the remains of the mammoth, hyæna, woolly rhinoceros, and other animals, under conditions that proved the contemporaneity of man with the extinct mammalia. And from that time down to the present date I have carried on researches in caves in various parts of Great Britain. In the district of Gower also, many ossiferous caverns were investigated, in 1858-9-60-1 by Colonel Wood and Dr. Falconer, and in one of them flint implements were obtained along with the bones of the extinct mammalia.[3] Kent's Hole, begun

[1] Prestwich, Phil. Trans. 1860. Proceed. Royal Soc. 1859.

[2] Quart. Geol. Journ. Jan. 1861.

[3] Falconer, Palæont. Mem. vol. ii. p. 498.

in 1865 by the British Association, and still being worked, furnishes annually a vast number of bones and teeth of hyænas, rhinoceroses, cave-bears, and horses, and other animals, along with flint and bone implements.[1]

In 1869 I had the good fortune to discover, and subsequently to explore, a group of sepulchral caves in Denbighshire, which had been used by an Iberian or Basque race in the Neolithic age (Chapter V.); and in the following year the Settle Cave Committee began their work in Yorkshire under my advice. And this has led to the important conclusion, that a group of caves, extending over a wide area in the centre and north of England, was occupied by the Brit-Welsh in the obscure interval which elapsed between the departure of the Roman legions and the English conquest.

France.—The researches of Buckland into the caves of Great Britain, and of Goldfuss and others into those of Germany, and more especially the publication of the "Ossemens Fossiles," by Cuvier, gave an impetus to cave-exploration in France which yielded the same results as in our own country. The mammalia obtained from the cave of Fouvent (Haut Saone) in 1800 were described in the "Ossemens," as well as those from Gondenans. In the Giroude, the Cave of Avison was explored by M. Billaudel in 1826-27. In the south, Marcel de Serres, aided by MM. Dubrueil and Jeanjean, examined the important Cave of Lunel-viel in 1824, and published their results in a work that holds the same position in France as the "Reliquiæ Diluvianæ" in England. The caverns of Pondres, Souvignargues, and of Bize were explored, the two first by M. Christol in 1829, the last by M. Tournal in 1833, and those of

[1] Rep. Brit. Assoc. 1865–72.

Villefranche (Pyrénées-orient), Mialet (Gard), and Nabrigas (Lozère) were described by De Serres in 1839, who subsequently added those of Carcas-sonne to the list in 1842. In this year MM. Prevost and J. Desnoyers explored the caves of Montmorency in the neighbourhood of Paris, and described the remains discovered in those of Bicêtre. The Cave of Pontil (Hérault) described by M. de Serres in 1847, was proved in 1864, by Professor Gervais, to contain two distinct strata, the neolithic lying over the palæolithic, as in Kent's Hole.[1]

In 1860,[2] the famous Cave of Aurignac was proved, by the investigations of Professor Lartet, to have been inhabited by man in the life-time of the extinct mammalia. Three years later the caves of Périgord were explored by that gentleman, along with Mr. Christy, and yielded results which mark a new era in the history of man in the remote past. From the remarkable collection of implements and weapons, the habits and mode of life of the occupants can be ascertained with tolerable certainty, and from their comparison with the like articles now in use among savage tribes, it may be reasonably inferred that they were closely related in blood to the Eskimos. This most important question will be investigated in its proper place, in the chapter relating to the palæolithic caves of France. Professor Lartet, M. Louis Lartet, Sir Charles Lyell, and other eminent observers believe further, that the interments that have been discovered in Aurig-

[1] The authorities for this paragraph are Cuvier (Oss. Foss.), Des noyers (Article "Grottes," Dictionnaire Univ. d'Histoire Naturelle) Marcel de Serres (Cavernes à Oss. Foss. du Département de l'Aude, 1839), Gervais (Paléontologie Française, 1859, and Nouvelles Recherches sur les Animaux Vertébrés, Vivants et Fossiles, 1868–9–70).

An. des Sc. : Nat. Zool. iv. sér. t. xv.

nac and in Cro Magnon,[1] in Périgord, are to be assigned to the same relative age as the occupation of the caves by man. From the fact, however, that the skeletons in both these cases were *above* the strata accumulated by the palæolithic cave-dwellers, it may be concluded that they were deposited after those strata were formed, in other words, that they are of a later age.

From 1863 down to the present time very many caves have been explored in France without any further addition to our knowledge, excepting the verification of the facts, afforded by the caves of Brixham and of Périgord, as to the co-existence of man with the extinct mammalia, and his probable identity in race with the Eskimos.

Belgium.—The caves of Belgium[2] have afforded evidence of precisely the same nature as those of England and France. Dr. Schmerling, of Liège, published the results of his researches, begun in 1829, into the bone-caves on the banks of the Meuse and its tributaries, in 1833-4, and proved that the mammoth, rhinoceros, cave-bear, and hyæna formerly lived in that district. He also arrived at the conclusion that man was living at that remote time, from the discovery of flint-flakes and human bones along with the remains of those animals in the caves of Engis and Engihoul. In 1853,[3] Professor Spring discovered a quantity of burned, broken, and cut bones belonging to women and children, in the Cave of Chauvaux, which he considered to imply that it had been inhabited by a family of cannibals. Axes of polished

[1] Reliquiæ Aquitanicæ.

[2] Recherches sur les Oss. Foss. découverts dans les Cavernes de la Province de Liège, 4to. atlas folio.

[3] Bull. de l'Académie Royale de Belgique, 1 sér. t. xx. p. 427, 1853; 2 sér. t. xviii. p. 479, 1864; xxii. p. 187, 1866.

stone were also met with, that indicated the relative age to be neolithic.

To pass over the human skeleton found in the Neanderthal Cave in 1857 by Dr. Fuhlroth, which is of doubtful antiquity, the next discoveries of importance are those made by M. Dupont in the years 1864–70, in the province of Namur, that established the fact that the same race of men who inhabited Auvergne in the palæolithic age had also lived in Belgium. M. Dupont considers that the interments in the Trou de Frontal[1] belong also to the palæolithic age, and that therefore man at that remote time was possessed of religious ideas. Before, however, this view can be accepted, it will be necessary to show the exact relation of the bones of the reindeer, chamois, mammoth, and other animals found outside the slab of stone, at the mouth of the sepulchral chamber, to the human remains within. In this case, as in Aurignac and Cro Magnon, the evidence seems to me insufficient to establish so important a conclusion.

Southern Europe.—In southern Europe the bone-caves of Sicily, worked in 1829 for the sake of the animal remains to be used in sugar refining, were scientifically examined by Dr. Falconer in 1859 ; those of Malta by Captain Spratt in the same year ; and those of Gibraltar by Captain Broome in the years 1862–8. They established the existence of the serval and the African elephant, and other characteristic African species, in Europe, and offer as we shall see in this work, important testimony as to the geography of the Mediterranean area in the Pleistocene age.

In this outline of the history of cave-exploration it

[1] L'Homme pendant les Ages de la Pierre dans les Environs de Dinant sur Meuse. Bruxelles, 1871. 2nd edit., 1872.

will be seen, that the additions to our knowledge of the past have been neither few nor insignificant, nor in one line of inquiry. And if the attention which is now being directed to the subject be due to the general development of scientific thought, it is equally true, that the results have reacted on scientific thought in general, and have especially benefited the sciences of geology, archæology, and history. A rich field of investigation lies before the cave-hunter, in Greece, Palestine, Lycia, Persia, and the limestone plateaux of central Asia; and since these discoveries have been so valuable in central and north-western Europe, what may we not recover from the grasp of oblivion, of the infancy and early culture of mankind in the very birth-place and "pathway of the nations"?

CHAPTER II.

PHYSICAL HISTORY OF CAVES.

Caves formed by the Sea and by Volcanic Action.—Caves in Arenaceous Rocks.—Caves in Calcareous Rocks of various ages.—Their Relation to Pot-holes, "Cirques," and Ravines.—The Water-cave of Wookey Hole.—The Goatchurch Cave.—The Water-caves of Derbyshire.—Of Yorkshire.—The Ingleborough Cave.—The Rate of Deposit of Stalagmite.—The Descent into Hellnpot.—The Caves and Pots round Weathercote.—The Formation of Caves, Pot-holes, and Ravines.—Caverns not generally formed in line of Faults.—Of various Ages.—Their Filling-up.—The Cave of Caldy.—The Blackrock Cave.—Great quantity of Carbonate of Lime dissolved by Atmospheric Water.—The Circulation of Carbonate of Lime.—The Temperature of Caves.—Conclusion.

Caves formed by the Sea and by Volcanic Action.

In this chapter we shall treat of the origin of caves and of their place in physical geography. The most obvious agent in hollowing out caves is the sea. The set of the current, the tremendous force of the breakers, and the grinding of the shingle, inevitably discover the weak places in the cliff, and leave caves as the results of their work, modified in each case by the local conditions of the rock. Caves formed in this manner have certain characters which are easily recognized. Their floors

are very rarely much out of the horizontal, their outlook is over the sea, and they very seldom penetrate far into the cliff. A general parallelism is also to be observed in a group in the same district, and their entrances are all in the same horizontal plane, or in a succession of horizontal and parallel planes. In some cases they are elevated above the present reach of the waves, and mark the line at which the sea formerly stood. From their generally inaccessible position sea-caves have very rarely been occupied by man, and the history of their formation is so obvious that it requires no further notice. Among them the famous Fingal's Cave, off the north coast of Ireland, and that of Staffa, on the opposite shore of Scotland, hollowed out of columnar basalt, are perhaps the most remarkable in Europe.

In volcanic regions also there are caves formed by the passage of lava to the surface of the ground, or by the imprisoned steam and gases in the lava while it was in a molten state: but these are of comparatively little importance so far as relates to the general question of caves, from the very small areas which are occupied by active volcanoes in Europe. They have been observed in Vesuvius, Etna, Iceland, and Teneriffe.

Caves in Arenaceous Rocks.

Caves also occur sometimes in sandstones, in which case they are the result of the erosion of the lines of the joints by the passage of subaërial water, and if the joints happen to traverse a stratum less compacted than the rest, the weak point is discovered, and a hollow is formed extending laterally from the original fissure. The massive

millstone grit of Derbyshire and Yorkshire present many examples of this, as for instance in Kinderscout in the former county. The rocks at Tunbridge Wells also show to what extent the joints in the Wealden sandstones may become open fissures, more or less connected with caves, on a small scale, by the mere mechanical action of water. M. Desnoyers gives instances of the same kind in the Tertiary sandstones of the Paris basin, which have furnished remains of rhinoceros, reindeer, hyæna, and bear. Caverns, however, in the sandstone are rarely of great extent, and may be passed over as being of small importance in comparison with those in the calcareous rocks.

Caves in Calcareous Rocks of various ages.

It has long been known that wherever the calcareous strata are sufficiently hard and compact to support a roof, caves are to be found in greater or less abundance. Those of Devonshire occur in the Devonian limestone; those of Somerset, Nottinghamshire, Yorkshire, Derbyshire, and Northumberland, as well as of Belgium and Westphalia, in that of the carboniferous age. In France also, those of Maine and Anjou, and most of those of the Pyrenees and in the department of Aude, are hollowed in carboniferous limestone, as well as the greater part of those in North America, in Virginia, and Kentucky. The cave of Kirkdale in Yorkshire, and most of those in Franconia and in Bavaria penetrate Jurassic limestones, which have received the name of Hohlenkalkstein from the abundance of caverns which they contain. They are developed on a large scale in the Swiss and French Jura, and in some cases afford passage to powerful streams.

and in others are more or less filled with ice, thus constituting the singular "glacières" that have been so ably explored by the Rev. G. F. Browne.[1]

The compact Neocomian and Cretaceous limestones contain most of the caverns of Périgord, Quercy, and Angoumois, and some of those in Provence and Languedoc, those of Northern Italy, Sicily, Greece, Dalmatia, Carniola, and Turkey in Europe, of Asia Minor and Palestine.

The tertiary limestones, writes M. Desnoyers,[2] offer sometimes, but very rarely, caves that have become celebrated for the bones which they contain, such as those of Lunel-Viel, near Montpelier, those of Pondres and Souvignargues, near Sommières (Gard), and of Saint Macaire (Gironde). The same may also be said of the calcaire grossier of the basin of Paris.

Certain rocks composed of gypsum also contain caverns of the same sort as those in the limestones. In Thuringia, for example, near Eisleben, they occur in the saliferous and gypseous strata of the zechstein, and are connected with large gulfs and cirques on the surface, which are sometimes filled with water. In the neighbourhood of Paris, and especially at Montmorency, they contain numerous bones of the extinct mammalia. M. Desnoyers points out their identity, in all essentials, with those in calcareous strata, and infers that they have been produced in the same way. Some of them may have been formed by the removal of the salt, which is very frequently interbedded with the gypsum, by the passage of water. In Cheshire the pumping of the

[1] Ice-caves, 8vo. 1865, Longmans.

[2] D'Orbigny, Dictionnaire Universel d'Histoire Naturelle, Article "Grottes."

brine from the saliferous and gypseous strata produces subterranean hollows, which sometimes fall in and eventually cause depressions on the surface, such as those which are now destroying the town of Northwich, and causing the neighbouring tidal estuary to extend over what was formerly meadow land. This explanation, however, will not apply to those in the neighbourhood of Paris, because there is no trace of their ever having contained salt.

The Relation of Caves to Pot-holes, "Cirques," and Ravines.

The caverns hollowed in calcareous rocks present features by which they are distinguished from any others. They open, for the most part, on the abrupt sides of valleys and ravines at various levels, being arranged round the main axis of erosion just as branches are arranged round the trunk of a tree—as, for example, in Cheddar Pass. The transition in some cases from the valley to the ravine, and from the ravine to the cave, is so gradual, that it is impossible to deny that all three are due to the same cause. The caves themselves ramify in the same irregular fashion as the valleys, and are to be viewed merely as the capillaries in the general valley system, through which the rainfall passes to join the main channels. Very frequently, however, the drainage has found an outlet at a lower level, and its ancient passage is left dry; but in all cases unmistakable proof of the erosive action of water is to be seen in the sand, gravel, and clay which compose the floor, as well as in the worn surfaces of the sides and the bottom.

In all districts in which caves occur are funnel-shaped

cavities of various sizes, known as "pot-holes" or "swallow-holes" in Britain, as "betoires," "chaldrons du diable," "marmites de géants," in France, and as "katavothra" in Greece, in which the rainfall is collected before it finally disappears in the subterranean passages. They are to be seen in all stages; sometimes being mere shallow funnels, that only contain water after excessive rain, and at others as profound vertical shafts, into which the water is continually falling, as in Helln Pot, in Yorkshire. The cirques, also, described by M. Desnoyers, belong to the same class of cavities, although all those which are mentioned by the Rev. T. G. Bonney,[1] at the head of valleys, and in some cases hollowed in shale and igneous rocks, are most probably to be referred to the vertical, chisel-like action of streams flowing under physical conditions, that resemble those under which the cañons of the Colorado, or of the Zambesi, are being excavated, and in which frost, ice, and snow have played a very subordinate part.

The intimate relation between pot-holes, caves, ravines, and valleys will be discussed in the rest of this chapter, and illustrated by English examples; and then we shall proceed to show that the chemical action of the carbonic acid in the rain-water, and the mechanical friction of the sand and gravel, set in motion by the water, by which Professor Phillips explains the origin of caves, will equally explain the pot-holes and ravines by which they are invariably accompanied.

[1] Quart. Geol. Journ. xxvii. 312.

The Water-Cave of Wookey Hole, near Wells, Somerset.

Caves may be divided into two classes: those which are now mere passages for water, in which the history of their formation may be studied, and those which are dry, and capable of affording shelter to man and the lower animals. Among the water-caves, that of Wookey Hole[1] is to be noticed first, since its very name implies that it was known to the Celtic inhabitants of the south of England, and since it was among the first, if not the first, of those examined with any care in this country, Mr. John Beaumont[2] having brought it before the notice of the Royal Society in the year 1680.

The hamlet of Wookey Hole nestles in a valley, through which flows the river Axe, and the valley passes insensibly, at its upper end, into a ravine, which is closed abruptly by a wall of rock (Fig. 1), about two hundred feet high, covered with long streamers and festoons of ivy, and affording scanty hold, on its ledges and in its fissures, to ferns, brambles, and ash saplings. At its base the river Axe issues, in full current, out of the cave, the lower entrance of which it completely blocks up, since the water has been kept back by a weir, for the use of a

1 When the English conquered Somerset from the Brit-Welsh, they translated the Celtic Ogo into Hole, whence the cave and village of Wookey Hole were named, just as they translated a neighbouring hill, called Pen, into Knowle, the generic Celtic term in each case being used to specify a particular object. There are many other instances of the like use of a Celtic name by the English conquerors of the Celts. In the Limestone plateau of Llanamynech, near Oswestry, there is a cave called "The Ogo."

2 Phil. Trans. 1680, p. 1.

paper-mill a little distance away. A narrow path through the wood, on the north side of the ravine, leads to the only entrance now open.[1] Thence a narrow passage leads downward into the rock, until, suddenly, you find yourself in a large chamber, at the water level. Then you pass

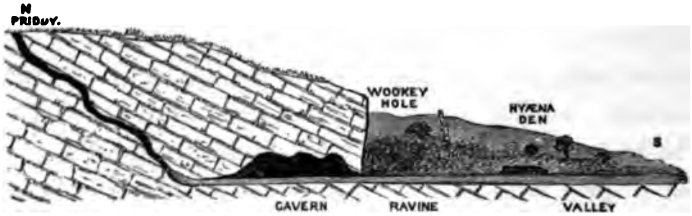


FIG. 1.—Diagram of Wookey Hole Cave and Ravine.

over a ridge, covered with a delicate fretwork of dripstone, with each tiny hollow full of water, and ornamented with brilliant lime crystals. One shapeless mass of dripstone is known in local tradition as the Witch of Wookey, turned into stone by the prayers of a Glastonbury monk. Beyond this the chamber expands considerably, being some seventy or eighty feet high, and adorned with beautiful stalactites, far out of the reach of visitors. The water, which bars further entrance, forms a deep pool, which Mr. James Parker managed to cross on a raft (see Appendix I.) into another chamber, which was apparently easy of access before the construction of the weir. It was in this further chamber that Dr. Buckland found human remains and pottery.

The cave has been proved to extend as far as the village of Priddy, about two miles off, on the Mendip hills, by the fact observed by Mr. Beaumont, that the water used in washing the lead ore at that spot, in his time, found its way into the river Axe, and poisoned cattle in

1 The cave is accessible, and can be examined without any climbing.

the valley of Wookey. And this observation has been verified during the last few years by throwing in colour and chopped straw. The stream at Priddy sinks into a swallow-hole (Fig. 1), and has its subterranean course determined by the southerly dip of the rock, by which the joints running north and south afford a more free passage to the water than those running east and west. The cave is merely a subterranean extension of the ravine in the same line, as far as the swallow-hole, and all three have been hollowed, as we shall see presently, by the action of the stream and of carbonic acid in the water.

The Goatchurch Cave.

The largest cavern in the Mendip hills is that locally known as the Goatchurch, which opens on the eastern side of the lower of the two ravines that branch from the magnificent defile of Burrington Combe, about two miles from the village of Wrington, at the height of about 120 feet from the bottom of the ravine. After creeping along a narrow, muddy passage, with a steep descent to the west, at an angle of about 30°, you suddenly pass into a stalactitic chamber of considerable height and size. From it two small vertical shafts lead into the lower set of chambers and passages ; the first being blocked up, and the second being close to a large barrel-shaped stalagmite, to which Mr. Ayshford Sanford, Mr. James Parker, and myself fastened our ropes when we explored the cave in 1864. The latter affords access into a passage, beautifully arched, and passing horizontally east and west, and just large enough to admit a man walking upright. At the further end numerous open

fissures, caused by the erosion of the joints in the limestone, cross it at right angles, and pass into several ill-defined chambers, partially stalactitic, but for the most part filled with loose, bare, cubical masses of limestone. Two of the transverse fissures lead into a large chamber, at a lower level. At its lower end, on crawling along a narrow passage, we came into a second chamber, also of considerable height and depth, at the bottom of which the noise of flowing water can be heard through two vertical holes, just large enough to admit of access. On sliding down one of these we found ourselves in a third chamber, which was traversed by a subterranean stream, doubtless in part the same which disappears in the ravine, at a point eighty feet above by aneroid measurement. The temperature of the water, as compared with that of the stream outside (49° : 59°), renders it very probable that, between the point of disappearance in the ravine and reappearance in the cave, it is joined by a stream of considerable subterranean length, since the water could not have lost ten degrees in the short interval which it had to traverse, were it supplied only from the stream in the ravine. From the point of its disappearance in the cave, the water passes downwards to join the main current flowing underneath Burrington Combe, that gushes forth in great volume at Rickford. The lowest portion of the cave was eighteen or twenty feet below the stream, and 220 feet below the entrance of the cavern.

On examining the floors of the chambers and passages, we discovered that they were composed of the same kind of sediment as that which is now being deposited by the water in Wookey Hole, and there could be no doubt but that they had been originally traversed by water. For

this to have taken place it is necessary to suppose that, while the Goatchurch was a water cave, the ravine on which it opens was not deeper than the entrance—in other words, that in the interval between the formation and excavation of the chambers and passages, to the present time, the ravine has been excavated in the limestone to a depth of a hundred and twenty feet, and the water which originally passed through the entrance has found its way, by a new series of passages, to the point where it appears at the bottom of the cave.

We obtained evidence that the horizontal passage, immediately below the first vertical descent, had been inhabited at a very remote period. At the spot where Mr. Beard, of Banwell, obtained a fine tusk of mammoth, we found a molar of bear, and a fragment of flint, which were imbedded in red earth, and were underneath a crust of stalagmite of about two inches in thickness. It would follow from this, that the date of the formation of this part of the cave was before the time when the traces of elephants, bears, and of man were introduced.

The cave is the resort of numerous badgers. On hiding ourselves in one of the transverse fissures, and throwing our light across the horizontal passage, these animals ran to and fro across the lighted field with extraordinary swiftness, and had it not been for the white streaks on the sides of their heads, which flashed back the light, they would not have been observed. Though they are rarely caught, they must be abundant in the district.

Like all the other large caverns in the district, it has its legends. The dwellers in the neighbourhood, who have never cared to explore its recesses, relate that a certain

dog put in here found its way out, after many days, at Wookey Hole, having lost all its hair in scrambling through the narrow passages. At Cheddar the same legend is appropriated to the Cheddar cave. At Wookey the dog is said to have travelled back to Cheddar. Some eighteen years ago, while exploring the limestone caves at Llanamynech, on the English border of Montgomeryshire, I met with a similar story. A man playing the bagpipes is said to have entered one of the caves, well provisioned with Welsh mutton, and after he had been in for some time his bagpipes were heard two miles from the entrance, underneath the small town of Llanamynech. He never returned to tell his tale. The few bones found in the cave are supposed to be those which he had picked on the way. This is doubtless another form of the story of the dog; both owe their origin to the vague impression, which most people have, of the great extent of caverns, and both versions are equally current in France and Germany.

The Water-caves of Derbyshire.

The celebrated cavern of the Peak, at Castleton in Derbyshire, presents the same essential character as that of Wookey Hole. It runs into the hill-side at the end of the ravine, and is traversed by a powerful stream of water, which has been met with in driving an horizontal adit in lead-mining at a considerable distance from the entrance, and finally traced to a distant swallow-hole. At a little distance from Buxton a smaller cave, known as Poole's Cavern, is in part traversed by water, which has found an outlet at a lower level, and allowed of the present entrance being used by the Brit-Welsh

(Romano-Celtic) inhabitants of the district as a habitation in the fifth and sixth centuries.[1] There are, besides these, very many others, some known, others unknown, that debouch on the sides of the dales in Derbyshire and Staffordshire, and are all well worthy of examination, since they illustrate not merely the history of the formation of caves, but also have been proved to contain works of art, pottery and flint implements, and the remains of animals, such as the mammoth and rhinoceros.

The Water-caves of Yorkshire.

The caves in the mountain limestone of Yorkshire rival in size those of Carniola, or those of Greece, and they are to be seen in all stages of formation. In their gloomy recesses all the higher qualities of a mountaineer may be exercised, and there is sufficient danger to give a keen zest to their exploration. The mountain streams sometimes plunge into a yawning chasm, locally known as a pot, and at others emerge from the dark portals of a cave in full current. There is, perhaps, no place in the world where the subterranean circulation of water may be studied with better advantage.

Ingleborough forms a centre from which the rainfall on every side finds its way into the dales, through a system of caves more or less complicated, which during the last forty years have been thoroughly explored by Mr. Farrer, Mr. Birkbeck, and Mr. Metcalfe. On the south it collects in a ravine, and then leaps into a deep bottle-shaped hole called "Gaping Gill," into which Mr.

[1] Both of these caves are kept in excellent order, and the latter is lighted with gas.

Birkbeck unsuccessfully attempted to descend, the sharp edges of the rock cutting the rope, and very nearly causing a serious accident. In depth it is about three hundred feet. The stream thence finds its way through a series of chambers and passages until it reappears in the famous Ingleborough cave, that was explored by Mr. Farrer in the year 1837, and proved to pass into the rock between seven and eight hundred yards.

The present entrance of the Ingleborough cave[1] is dry, except after heavy rains, when the current reverts to its old passage. The following admirable account of the interior is given by Professor Phillips:—[2]

"From Mr. Farrer's plan and description, as given in the 'Proceedings of the Geological Society,' June 14, 1848, and from information obligingly communicated to me, a clear notion of the history of this most instructive spar grotto may be formed. For about eighty yards from the entrance the cave has been known immemorially. At this point Josiah Harrison, a gardener in Mr. Farrer's service, broke through a stalagmitical barrier which the water had formed, and obtained access to a series of expanded cavities and contracted passages, stretching first to the N., then to the N.W.; afterwards to the N. and N.E., and finally to the E., till after two years spent in the interesting toil of discovery, at a distance of 702 yards from the mouth, the explorers rested from their labours in a large and lofty irregular grotto, in which they heard the sound of water falling in a still more advanced subterranean recess. It has been ascertained, at no inconsiderable personal risk, that

[1] The cave is admirably preserved by the care of the owner, J. Farrer, Esq., and may be visited without any difficulty.

[2] Rivers, Mountains, and Sea-coast of Yorkshire, 8vo. 1854, p. 34.

this water falls into a deep pool or linn at a lower level, beyond which further progress appears to be impracticable. In fact Mr. Farrer explored this dark lake by swimming—a candle in his cap and a rope round his body.

"In this long and winding gallery, fashioned by nature in the marble heart of the mountain, floor, roof, and sides are everywhere intersected by fissures which were formed in the consolidation of the stone. To these fissures and the water which has passed down them, we owe the formation of the cave and its rich furniture of stalactites. The direction of the most marked fissures is almost invariably N.W. and S.E., and when certain of these (which in my geological work I have called master fissures) occur, the roof of the cave is usually more elevated, the sides spread out right and left, and often ribs and pendants of brilliant stalactite, placed at regular distances, convert the rude fissure into a beautiful aisle of primæval architecture. Below most of the smaller fissures hang multitudes of delicate translucent tubules, each giving passage to drops of water. Splitting the rock above, these fissures admit, or formerly admitted, dropping water: continued through the floor, the larger rifts permit, or formerly permitted, water to enter or flow out of the cave. By this passage of water, continued for ages on ages, the original fissure was in the first instance enlarged, through the corrosive action of streams of acidulated water; by the withdrawal of the streams to other fissures, a different process was called into operation. The fissure was bathed by drops instead of streams of water, and these drops, exposed to air currents and evaporation, yielded up the free carbonic acid to the air and the salt of lime to the rock. Every

line of drip became the axis of a stalactitical pipe from the roof; every surface bathed by thin films of liquid became a sheet of sparry deposit. The floor grew up under the droppings into fantastic heaps of stalagmite, which, sometimes reaching the pipes, united roof and floor by pillars of exquisite beauty."

At the time of its exploration, the water stood at a considerably higher level inside than at the present time, and formed deep pools. The barrier of dripstone has been cut through, and the water level lowered, and a passage made for a considerable distance. Inside, the old water line, which separated the subaërial from the subaqueous dripstone, is very distinct, the former being deposited in thick bosses, crumpled curtains, drops, straws, pyramids, and other fantastic drip-structures, while the latter is honeycombed, and composed of rounded, grape-like masses. Between them an ice-like coating of stalagmite forms a dividing line, now supported in mid air, but that formerly shot across the surface of the pools that have been drained, or rested on the mud and stones which had been brought down by the stream in ancient times. In some places it still rests on the surface of the pools.

A stalactitic curtain on the right-hand side presents a very singular appearance, its surface being covered with an abundant crop of tiny club-like bodies about one-tenth of an inch in length, and consisting each of a shining drop of water, enclosing a minute fungus. These may possibly explain in some degree the peculiar fungoid-appearance of certain small bosses of dripstone which I have met with in the caves of Pembrokeshire: for an accumulation of carbonate of lime on such a nucleus would produce the forms which they assume (see Fig. 17).

There are also magnificent groups of dripstone, and each joint in the rock is adorned with lines, and pipes, and fringes of calc spar, or widened out into roof-shaped hollows, and traversed by deep, vertical grooves, caused by the passage of water laden with carbonic acid. The general surface of the roof, where the rock is bare, has had its fossils etched out by the acidulated water. In one place you may stand under a branching coral, with its sides and base distinctly marked, and in another fossil shells stand out almost in their original beauty.

Rate of the Accumulation of Stalagmite.

The rate at which the calcareous matter is being deposited at the present time is very easy to be estimated, for that accumulated since the passage was cleared out is white, and contrasts with the dirty, grey-red colour of the older kind. In one case a thickness of 0·24 had been formed in thirty-five years, by the water flowing down the side of the passage excavated by Mr. Farrer, while in another, in about the same time, 0·05 inch had been formed. This would give an annual accumulation of 0·0068 in the one case, and in the other about one-fifth of that amount. This rate does not agree with the rate of increase noted by Mr. Farrer and Professor Phillips in the case of a large stalagmite called the Jockey Cap, on which a line of drops is continually falling from one point in the roof. Its circumference in 1839 measured 118 inches, in 1845, 120 inches, and in 1873, I found it to be 128 inches. The annual rate of increase from 1845 to 1873 is ·2941 inch, and that from 1839 to 1845 is ·2857. I found, however, that the most remarkable increase was that

in height. In 1845 its apex was 95·25 inches from the roof, in 1873, 87 inches, which would imply an annual deposit of not less than ·2946. (See Appendix II.) At this rate it will arrive at the roof in about 295 years. But even this comparatively short lapse of time will probably be diminished by the growth of a pendant stalactite above, that is now being formed in place of that which measured 10 inches in 1845, and has since been accidentally destroyed.

It is very possible that the Jockey Cap may be the result, not of the continuous, but of the intermittent drip of water containing carbonate of lime, and that therefore the present rate of growth is not a measure of its past or future condition. Its age in 1845 was estimated by Professor Phillips at 259 years, on the supposition that all or nearly all of the carbonate of lime in each pint was deposited. If, however, it grew at its present rate, it may be not more than 100 years old; and if it be taken as a measure of the rate generally, all the stalagmites and stalactites in the cave may not date further back than the time of Edward III.

It is evident, from this instance of rapid accumulation, that the value of a layer of stalagmite in measuring the antiquity of deposits below it, is comparatively little. The layers, for instance, in Kent's Hole, which are generally believed to have demanded a considerable lapse of time, may possibly have been formed at the rate of a quarter of an inch per annum, and the human bones which lie buried under the stalagmite in the cave of Bruniquel, are not for that reason to be taken to be of vast antiquity. It may be fairly concluded, that the thickness of layers of stalagmite cannot be used as an argument in support of the remote age of the strata

below. At the rate of a quarter of an inch per annum, twenty feet of stalagmite might be formed in 1,000 years.

The Descent into Helln Pot.

The subterranean passages grouped round Helln Pot, a tremendous chasm near Selside, on the east of Simon's Fell in Ribblesdale, illustrate in a remarkable degree the mode in which the water is at present wearing away the rock. Those which have been explored constitute the Long Churn Cavern, which is comparatively easy of access through a hole known as Diccan Pot (Fig. 2, *a*). On descending into it, the visitor finds himself in the bed of a stream that now roars in a waterfall, now gurgles over the large fallen blocks from the roof, and that here and there has worn for itself deep pools by the mechanical friction of the sand and pebbles brought down by the current. If it be followed down after passing over a waterfall, the light of day is seen streaming upwards beneath the feet from the point where the water leaps into the great chasm of Helln Pot (Figs. 2, *b*. 3, *a*). Above the entrance there is a complicated network of passages, some dry, and some containing streams which have not yet been fully explored.

FIG. 2.—Diagram of Helln Pot and the Long Churn Cavern.

The two actions by which caves are hewn out of the calcareous rock are seen here in operation side by side. Below the level of the stream the rock is seen to be smoothed and polished by the mechanical action of the materials swept down by the current. Above the water-

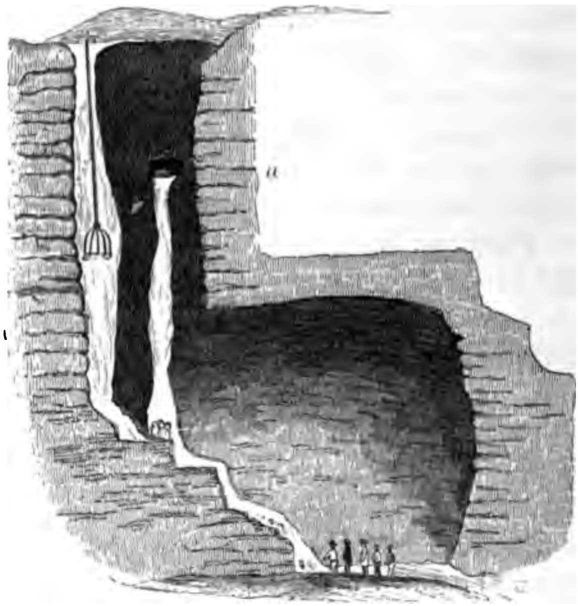


FIG. 3.—Diagram of Helln Pot.

level the sides of the cave are honeycombed and eaten into the most fantastic and complex shapes, the resultant surface (see Fig. 7) bearing small points and keen knife-edges of stone, that stand out in relief and mark the less soluble portions of the rock. This is due to the chemical effect of the carbonic acid in the water percolating through the strata.

The Helln Pot, into which the stream flowing through the Long Churn Cave falls, is a fissure (Figs. 2, 3, 4)

a hundred feet long by thirty feet wide, that engulfs the waters of a little stream on the surface, which are dissipated in spray long before they reach the bottom. From the top you look down on a series of ledges, green with ferns and mosses, and, about a hundred feet from the surface, an enormous fragment of rock forms a natural bridge across the chasm from one ledge to another. A little above this is the débouchement of the stream flowing through the Long Churn Cave (Fig. 3, *a*), through which Mr. Birkbeck and Mr. Metcalfe made the first perilous descent in 1847. The party, consisting of ten persons, ventured into this awful chasm with no other apparatus than ropes, planks, a turn-tree, and a fire-escape belt. On emerging from the Long Churn Cave they stood on a ledge of rock about twelve feet wide, and which gave them free access to the "bridge" (Fig. 2, *b*). This was a rock ten feet long, which rested obliquely on the ledges. Having crossed over this, they crept behind the waterfall which descended from the top, and fixed their pulley, five being let down while the rest of the party remained behind to hoist them up again. In this way they reached the bottom of the pot, which before had never been trod by the foot of man. Thence they followed the stream downwards as far as the first great waterfall, down which Mr. Metcalfe was venturesome enough to let himself with a rope, and to push onwards until daylight failed. He was within a very little of arriving at the end of the cave into which the stream flows, but was obliged to turn back to the daylight without having accomplished his purpose. The whole party eventually, after considerable danger and trouble, returned safely from this most bold adventure.

A second descent was made in 1848 from the surface,

and a third in the spring of 1870, in both of which Mr. Birkbeck took the lead. The apparatus employed consisted of a windlass (Fig. 3), supported on two baulks of timber, and a bucket, covered with a shield, sufficiently large to hold two people, and two guiding ropes to prevent the revolution of the bucket in mid air. There was also a party of navvies to look after the mechanical contrivances, and two ladders about eight feet long to provide for contingencies at the bottom. Thirteen of us went down, including three ladies. As we descended, the fissure gradually narrowed, until at the bottom it was not more than ten feet wide. The actual vertical descent was a hundred and ninety-eight feet. After running the gauntlet of the waterfall we landed in the bed of the stream, which hurried downwards over large boulders of limestone and lost itself in the darkness of a large cave, about seventy feet high. We traced it downwards, through pools and rapids to the first waterfall, of about twenty feet. This obstacle prevented most of the party going further, for the ladders were too short to reach to the bottom. By lashing them together, however, and letting them down, we were able to reach the first round with the aid of a rope, and to cross over the deep pool at the bottom. Thence we went on downwards through smaller waterfalls and rapids, until we arrived at a descent into a chamber, where the roar of water was deafening. Down to this point the daylight glimmered feebly, but here our torches made but little impression on the darkness. One of the party volunteered to go down with a rope, and was suddenly immersed in a deep pool; the rest, profiting by his misadventure, managed to cling on to small points of rock, and eventually to reach the floor

of the chamber. We stood at last on the lowest accessible point of the cave, about 300 feet from the surface. It was indeed one of the most remarkable sights that could possibly be imagined. Besides the waterfall down which we came, a powerful stream poured out of a cave too high up for the torches to penetrate the darkness, and fell into a deep pool in the middle of

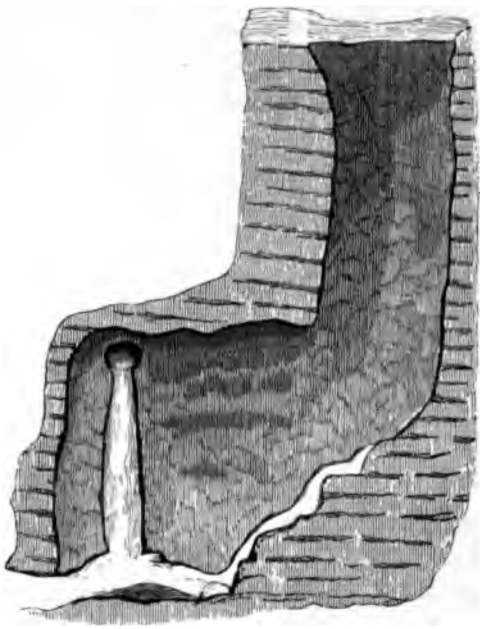


FIG. 4.—Diagram of Helln Pot, showing Waterfall at the Bottom.

the floor, causing such a powerful current of air that all our torches were blown out except one. The two streams eventually united and disappeared in a small black circling pool, which completely barred further ingress.

The floor of the pot and the cave was strewn with masses of limestone rounded by the action of the streams; and the water-channels were smoothed and

grooved and polished, in a most extraordinary way, by the silt and stones carried along by the current. Some of the layers of limestone were jet black, and others were of a light fawn-colour, and as the strata were nearly horizontal, the alternation of colours gave a peculiarly striking effect to the walls. Beneath each waterfall was a pool more or less deep, and here and there in the bed of the stream were holes, drilled in the rock by stones whirled round by the force of the water. High up, out of the present reach of the water, were old channels, which had evidently been watercourses before the pot and cave had been cut down to their present level. In the sides of the pot there are two vertical grooves reaching very nearly from the top to the bottom, which are unmistakeably the work of ancient waterfalls. There was no stalactite, but everywhere the water was wearing away the rock and enlarging the cave. We found our way back without any difficulty, a small passage on the right-hand side enabling us to avoid the very unpleasant task of scrambling up two of the waterfalls. We arrived finally at the top, after about five hours' work in the cave, wet to the skin.

We had very little trouble in making this descent, because of the completeness of Mr. Birkbeck's preparations; but we could fully realize what a dangerous feat the first explorers performed when they ventured into an unknown chasm, comparatively unprepared. The very name "Helln Pot," = Ællan Pot, or Mouth of Hell, testifies to the awe with which the Angles looked down into its recesses.[1]

Such is the interior of one of those great natural laboratories in which water is wearing away the solid

[1] On the Ordnance Maps it is wrongly printed Alum Pot.

rock, either hollowing it into caves or cutting it into ravines. At the bottom of Helln Pot it was impossible not to realize, that the enormous chasm had been formed by the same action as that by which it was being deepened before our eyes. It was merely a portion of the vast cave into which it led, which had been deprived of its roof, and opened out to the light of heaven. The bridge was but a fragment of the roof which happened to fall upon the two ledges. The rounded masses of rock at the bottom are fragments that have fallen probably within comparatively modern times. The absence of stalactites and of stalagmites proves that the destructive action is rapidly going on.

The water-course at the bottom contained pebbles and boulders of limestone, and gritstone rounded by friction against one another and the rocky floor. The gritstone has probably been derived from the wreck of the boulder clay on the surface above the Helln Pot, and ultimately torn from the millstone grit of the higher hills in the district.

Caves and Pots at Weathercote.

On the north side of Ingleborough the series of caves and pots round the little Church of Chapel-en-le-Dale are especially worthy of attention. The chasm at Weathercote opens suddenly in the hill-side, and is perfectly accessible to visitors. You come suddenly upon a cleft a hundred feet deep, with its ledges covered with mosses, ferns, and brambles; at one end a body of water rushes from a cave, and under a great bridge of rock, and falls seventy-five feet, a mass of snow-white foam filling the bottom with spray (Fig. 5). The large masses of rock piled in wild confusion at the

bottom, the dark shadows of the overhanging ledges, and the thick covering of green moss, to which the spray clings in tiny glittering drops, form a picture which cannot easily be forgotten. In the sunshine an almost circular rainbow is to be seen from the bottom. The stream passes from the bottom into a cave, and thence downwards to two large pots (Fig. 6), about two hundred yards away. In flood-time the channel has been known to become blocked up, and Weathercote has

FIG. 5. Waterfall in Pot-hole at Weathercote.

been filled to the brim. Usually after heavy rains the current is said to flow so violently into the first of the pot-holes, that it throws up stones at least thirty or forty feet from the bottom, with a peculiar rattling noise. From this strange phenomenon it is known as Jingle Pot, while the lower of the two is termed Hurtle Pot, because in

flood-time the water whirls so fast round, that it is "hurtled" out at the top. The water flowing through Weathercote is derived from the little stream of Ellerbeck, which disappears in the limestone hills about a mile to the north, and runs at right angles to Dalebeck, or the stream flowing down to Ingleton, which it has been proved to join at a spot below Jingle Pot, by Mr. Metcalfe, who made his way down into it from the chasm of Weathercote.

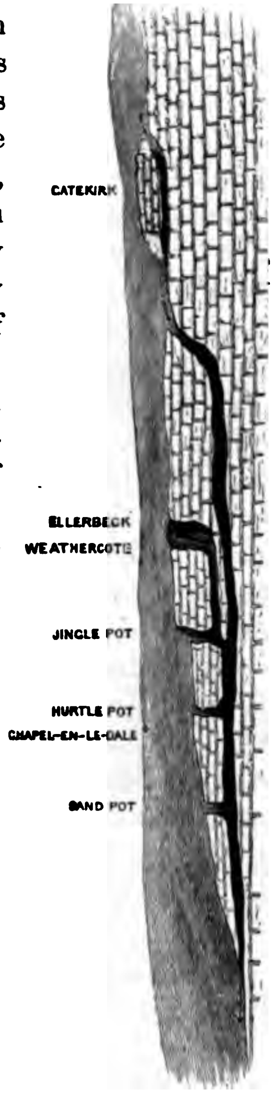


FIG. 6.—Diagram of Subterranean Course of Dalebeck.

The course of Dalebeck, as you pass up the valley of Chapel-en-le-Dale, affords a striking instance of the dependence of scenery upon the nature of the rock. In its lower portion it has cut out for itself a deep ravine in the hard Silurian strata, in which you come upon the waterfalls, deep pools, and trees, that look as if they had been transported bodily from the district of Cader Idris, and inserted into the limestone scenery of the dales. The Silurian rocks are very much contorted, and on their waterworn edges lie the nearly horizontal limestone strata, in which the upper part of the valley has been scooped. As we rise the ravine opens into a valley (Fig. 6), along which the

beck flows, until suddenly it is lost in a fissure, at a place called Godsbridge. Its subterranean course is marked, first of all, by a small depression known as Sandpot, and still higher by Hurtle Pot. It ultimately reappears at the surface, above Weathercote, and after passing through a picturesque cavern, known as the Gatekirk, its fountain-head is reached. The subterranean portions of its course are in the same right line as the open valley, and the pot-holes have been formed in the same manner as Helln Pot, by the passage of water at a time when the drainage found its way down the valley at a higher level than at present, very much as it does now in times of extraordinary floods.

Water-caves such as these are by no means uncommon in Yorkshire. In the dales there is scarcely a mass of limestone without its subterranean water system, as well as channels deserted by water, which are now dry caves situated at higher levels. These are always arranged on the line of the natural drainage, and generally open on the sides of the valleys and precipices. If you look northward from the flat crown of Ingleborough, you can see the ravines which radiate from it on the surface of the shale below, abruptly ending in pot-holes when they reach the limestone. In each case the streams reappear, issuing out of the caves at the points in Chapel-en-le-Dale, where the horizontal beds of limestone rest on the upturned edges of the impermeable Silurian rocks.

The Formation of Caves and their Relation to Pot-holes and Ravines.

The general conditions under which caves occur in limestone rocks, and the phenomena which they present,

may be gathered from the above examples. Universally the pot-holes, ravines, and caverns are so associated together, that there can be but little doubt that they are due to the operation of the same causes.

It requires but a cursory glance to see at once that running water was the main agent. The limestone is so traversed by joints and lines of shrinkage, that the water rapidly sinks down into its mass, and collects in small streams, which owe their direction to the dip of the strata and the position of the fissures. These channels are being continually deepened and widened by the mere mechanical action of the passage of stones and silt. But this is not the only way in which the rock is gradually eroded. The limestone is composed in great part of pure carbonate of lime, which is insoluble in water. It is, however, readily dissolved in any liquid containing carbonic acid, which is an essential part of our atmosphere, is invariably present in the rain-water, and is given off by all organic bodies. By this invisible agent the hard crystalline rock is always being attacked in some form or another. The very snails that take refuge in its crannies leave an enduring mark of their presence in a surface fretted with their acid exhalations, which sometimes pass current among geologists for the borings of pholades, and are the innocent cause of much speculation as to the depression of the mountain-tops beneath the sea in comparatively modern times. The carbonic acid taken up by the rain is derived, in the main, from the decomposing vegetable matter which generally forms the surface soil on the limestone.

The view from the ancient camp on the top of Ingleborough offers a striking example of the effect of rain-water in eroding the surface of the limestone. As you

look down over the dark crags of millstone grit, great, grey, pavement-like masses of limestone strike the eye, standing above the heather, perfectly bare, and in the distance resembling clearings, and in rainy weather sheets of snow. On approaching them the surface of erosion becomes more and more apparent, and the shapes due to the mere accident of varying hardness in the rock, or the varying quantity of water passing over it, present a most astonishing variety. There are, however, general principles underlying the confusion. The lines of joints in the strata being lines of weakness, searched out by the acid-laden water, have been widened into chasms, sometimes of considerable depth; and as they cross at right angles, the whole surface is formed of rectangular masses, each insulated from its fellow, and some of them detached from the strata beneath so as to form rocking-stones. The mode in which the acid has attacked one of these joints in the limestone of Doveholes in Derbyshire is represented in Figure 7, the surface being honeycombed and worn into sharp points, solely by chemical action. The minute fossil-shells also, and fragments of crinoid standing out in bold relief, lead to the same conclusion—that the denuding agent is chemical and not mechanical. Each of the upper surfaces of the blocks is traversed by small depressions, which are valley systems in miniature, in which the tiny valleys converge into a main trunk leading into the nearest chasm. There are also tiny caves and hollows, that are sometimes mistaken for borings made by pholas. In the chasms the vegetation is most luxuriant, and the dark green fronds of harts-tongue, the delicate

FIG. 7.—Diagram of an acid-worn joint, Doveholes, Derbyshire.

Lady-fern, and the graceful *Asplenium nigrum* grow with a rare luxuriance.

In these pavements every feature of limestone scenery is represented on a minute scale. There are the valley systems on the surface, determined by the direction of the drainage; the long chasms represent the open valleys and ravines, and the caves and hollows, for the most part, run in the line of the joints.

The carbonic acid has left precisely the same kind of proof of its work within the caves as we find above-ground; and it would necessarily follow, that to it, as well as to the mechanical power of the waters flowing through them, their formation and enlargement must be due, as Professor Phillips has pointed out in his "Rivers, Mountains, and Sea Coast of Yorkshire," pp. 30–1.

From the preceding pages it will be seen that caves in calcareous rocks are merely passages hollowed out by water, which has sought out the lines of weakness, or the joints formed by the shrinkage of the strata during their consolidation. The work of the carbonic acid is proved, not merely by the acid-worn surfaces of the interior of the caves, but also by the large quantity of carbonate of lime which is carried away by the water in solution. That, on the other hand, of the mechanical friction of the stones and sand against the sides and bottom of the water-courses, is sufficiently demonstrated by their grooved, scratched, and polished surfaces, and by the sand, silt, and gravel carried along by the currents. The generally received hypothesis, that they have been the result of a subterranean convulsion, is disproved by the floor and roof being formed, in very nearly every case, of solid rock; for it would be unrea-

sonable to hold that any subterranean force could act from below, in such a manner as to hollow out the complicated and branching passages, at different levels, without affecting the whole mass of the rock. Nor is there cause for holding the view put forth by M. Desnoyers[1] or M. Dupont,[2] that they are the result of the passage of hydrothermal waters. The causes at present at work, operating through long periods of time, offer a reasonable explanation of their existence in every limestone district; and those which are no longer watercourses can generally be proved to have been formerly traversed by running water, by the silt, sand, and rounded pebbles which they contain. In their case, either the drainage of the district has been changed by the upheaval or depression of the rock, or the streams have searched out for themselves a passage at a lower level.

But if caves have been thus excavated, it is obvious that ravines and valleys in limestone districts are due to the operation of the same causes. If, for instance, we refer to Figures 1 and 6, we shall see that the open valley passes insensibly into a ravine, and that into a cave. The ravine is merely a cave which has lost its roof, and the valley is merely the result of the weathering of the sides of the ravine. There can be no manner of doubt but that, in both these cases, the ravine is gradually encroaching on the cave, and the valley on the ravine; and if the strata be exposed to atmospheric agencies long enough, the valley of the Axe will extend as far as Priddy (Fig. 1), and that of Dalebeck to the watershed above the Gatekirk cave (Fig. 6).

[1] Op. cit. Article Grottes.

[2] L'Homme pendant les Ages de la Pierre dans les Environs de Dinant sur Meuse, Bruxelles, 1871.

In the same manner the lofty precipice of Malham Cove, near Settle, in Yorkshire (Fig. 8), is slowly falling away and uncovering the subterranean course of the Aire. Eventually the ravine thus formed will extend as far as Malham Tarn, and the Aire flow exposed to the light of day from its source to the sea.[1]

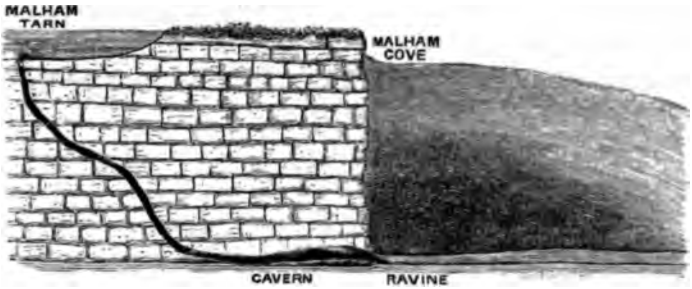


FIG. 8.—Diagram of Source of the Aire at Malham.

This view is applicable to many if not to all ravines and valleys in calcareous rocks, such as the Pass at Cheddar, or the gorge of the Avon at Clifton, and those of Derbyshire, Yorkshire, and Wales. And since the agents by which the work is done are universal, and calcareous rock for the most part of the same chemical composition, the results are the same, and the calcareous scenery everywhere of the same type. In the lapse of past time, so enormous as to be incapable of being grasped by the human intellect, these agents are fully capable of producing the deepest ravines, the widest valleys, and the largest caves.

This view of the relation of caves to ravines was so strongly held by M. Desnoyers, that he terms the latter "cavernes à ciel ouvert." I arrived independently at

[1] The bare pavements above Malham Cove are worthy of a careful examination.

the same conclusion after the study of the scenery of limestone for many years.

In many cases, however, in northern latitudes and in high altitudes, the ravine or valley so formed has been subsequently widened and deepened by glacial action. That, for instance, of Chapel-en-le-Dale bears unmistakeable evidence of the former flow of a glacier, in the *roches moutonnées* and travelled blocks that it contains. To this is due the flowing contour and even slope of its lower portion.

The pot-holes and "cirques" in calcareous rocks with no outlet at the surface, may also be accounted for by the operation of the same causes as those which have produced caves. Each represents the weak point towards which the rainfall has converged, caused very generally by the intersection of the joints. This has gradually been widened out, because the upper portions of the rock would be the first to seize the atoms of carbonic acid, and thus be dissolved more quickly than the lower portions. Hence the funnel shape which they generally assume, and which can be studied equally in the compact limestone or in the soft upper chalk. They are to be seen on a small scale also in all limestone "pavements." Sometimes, however, the first chance which the upper portions of the funnels have of being eroded by the acidulated water, is more than counterbalanced by the increased quantity converging at the bottom, and the funnel ends in a vertical shaft. If the area in the rock thus excavated be sufficiently large to allow of the development of a current of water, the mechanical action of the fragments swept along its course will have an important share in the work, as we have seen to be the case in Helln Pot.

Caves not generally found in Line of Faults.

In some few cases the lines of weakness which have been worn into caves, pot-holes, ravines, and valleys, may have been produced, as M. Desnoyers believes, by subterranean movements of elevation and depression; but in all those which I have investigated the faults do not determine the direction of the caverns. The mountain limestone of Castleton, in Derbyshire, offers an example of caves intersecting faults without any definite relation being traceable between them. The ramifications of the Peak cavern traverse the Speedwell Mine nearly at right angles, and the water flowing through it has been traced, Mr. Pennington informs me, to a swallow-hole near Chapel-en-le-Frith, running across two, if not three faults, which are laid down in the geological map. As a general rule caverns are as little affected by disturbance of the rock as ravines and valleys which have been formed in the main irrespective of the lines of fault.

M. Desnoyers points out the close analogy between caverns and mineral veins, and infers that both are due to the same causes. This, undoubtedly, exists in that class of veins which are known to miners as "pipe" and "flat veins;" and there is clear proof, in the majority of cases, that the cavities in which the minerals occur have been formed by the action of running water, and have subsequently been more or less filled with their mineral contents; and these have been deposited on the sides of the cavity by the same "incretionary[1]"

[1] I have used the term incretionary as implying an accumulation of mineral matter from the circumference of a cavity towards its centre,

action, as that by which dripstone is now being formed in the present caves from the solution of carbonate of lime. Such veins present every conceivable form of irregularity, and frequently contain silt, sand, and gravel, which have been left behind by their streams, and their history is identical with that of the caverns.

It is not so, however, with the second class of veins, the "rake," "right running," and "cross courses," as the miners term them, or those which occupy lines of fault. The fissures which contain the ore are proved very frequently, by their scratched and grooved sides, and polished surfaces or slicken-sides, to have been the result of subterranean movements by which the rock has been broken by mechanical force. They have been subsequently modified, in various ways, by the passage of water, and filled with minerals, in the same manner as the preceding class. With this exception they present no analogy to the caverns, with which they contrast strongly in their rectilinear direction, as well as in their purely mechanical origin.

The various Ages of Caves.

It is very probable that caves were formed in calcareous rocks from the time that they were raised to the level of the sea, since they abound in the Coral Islands. "Caverns," writes Prof. Dana,[1] "are still more remarkable on the Island of Atiu, on which the coral-reef

as in the case of an agate. Concretionary action, with which it is generally confused, ought to be defined as the deposition of successive layers of matter round a nucleus or centre. The one action operates from the circumference to the centre, the other from the centre to the circumference.

[1] Corals and Coral Islands, 1872, p. 361.

stands at about the same height above the sea as on Oahu. The Rev. John Williams states—that there are seven or eight of large extent on the Island of Tuto; one he entered by a descent of twenty feet, and wandered a mile in one only of its branches, without finding an end to 'its interminable windings.' He says—'Innumerable openings presented themselves on all sides as we passed along, many of which appeared to be equal in height, beauty, and extent to the one we were following. The roof, a stratum of coral-rock fifteen feet thick, was supported by massy and superb stalactitic columns, besides being thickly hung with stalactites from an inch to many feet in length. Some of these pendants were just ready to unite themselves to the floor, or to a stalagmitic column rising from it. Many chambers were passed through whose fret-work ceilings and columns of stalactites sparkled brilliantly, amid the darkness, with the reflected light of our torches. The effect was produced not so much by single objects, or groups of them, as by the amplitude, the depth, and the complications of this subterranean world.'"

Calcareous rocks might, therefore, be expected to contain fissures and caves of various ages. In the Mendip Hills they have been proved by Mr. Charles Moore to contain fossils of Rhætic age, the characteristic dog-fishes, *Acrodus minimus*, and *Hybodus reticulatus*, the elegant sculptured Ganoid fish, *Gryrolepis tenuistriatus*, and the tiny marsupials, Microlestes and its allies. This singular association of terrestrial with marine creatures is due to the fact, that while that area was being slowly depressed beneath the Rhætic and Liassic seas, the remains were mingled together on the coast-line, and washed into the crevices and holes in the rock.

The older caves and fissures have very generally been blocked up by accumulations of calc-spar or other minerals, and they are arranged on a plan altogether independent of the existing systems of drainage.

It is a singular fact that no fissures or caves should, with the above exception, contain the remains of animals of a date before the Pleistocene age. There can be but little doubt that they were used as places of shelter in all ages, and they must have entombed the remains of the animals that fell into them, or were swept into them by the streams. Caves there must have been long before, and the Eocene Palæotheres, and Anoplotheres met their death in the open pit-falls, just as the sheep and cattle do at the present time. The Hyænodon of the Meiocene had, probably, the same cave-haunting tastes as his descendant, the living Hyæna, and the marsupials of the Mesozoic age might be expected to be preserved in caves, like the fossil marsupials of Australia. The chances of preservation of the remains when once cemented into a fine breccia, or sealed down with a crystalline covering of stalagmite, are very nearly the same as those under which the Pleistocene animals have been handed down to us. The only reasonable explanation of the non-discovery of such remains seems to be, that the ancient suites of caves and fissures containing them, and for the most part near the then surface of the rock, have been completely swept away by denudation, while the present caverns were either then not excavated or inaccessible.

Such an hypothesis will explain the fact that the non-ossiferous caverns are older than the Pleistocene age, not merely in Europe, but in North and South America, Australia, and New Zealand. The effect of denudation in rendering the geological record imperfect, may be

gathered from the estimate, which Mr. Prestwich has formed, of the amount of rock removed from the crests of the Mendips and the Ardennes, which is in the one case a thickness "of two miles and more," and in the other as much as "three or four miles."[1] Under these conditions we could not expect to find a series of bone caves reaching far back into the remote geological past, since the caves and their contents would inevitably be destroyed.

The Filling up of Caves.

We must now consider the condition under which caves become filled up with various deposits. If the velocity of the stream in a water-cave be lessened, the silt, sand, or pebbles it was hurrying along will be dropped, and may ultimately block up the entire water-course. In bringing this to pass, however, the carbonate of lime in the water plays a most important part. If the excess of carbonic acid by which it is held in solution be lost by evaporation, it immediately reassumes its crystalline form, and shoots over the surface of the pool like plates of ice, or is deposited in loose botryoidal masses at their sides and on their bottoms; and, since the atmospheric water very generally percolates through the crannies in the rock, the sides and roof of the channel, above the level of the water, are adorned with a stony drapery of every conceivable shape. The rate at which this accumulation takes place depends upon the free access of air necessary for evaporation, and is therefore variable,—as in the case of the Ingleborough cave. In all the caves which I have examined

[1] Prestwich, Ann. Address Geol. Soc. 1872, p. 84.

there is a free current of air. If a water-channel becomes blocked up by either or both these causes, the joints and fissures in the rock offer an outlet to the drainage, more or less free, at a lower level, as in the Ingleborough cave, Poole's cave, near Buxton, and many others. Sometimes, however, owing to the increased rain-fall, or to the obstruction of the lower channels, the water re-excavates the old passages, as we shall see to have been the case with the famous caverns of Kent's Hole and Brixham. In the summer of 1872, a sudden rain-fall not merely opened out for itself a new passage into a swallow-hole close to Gaping Gill, on the flanks of Ingleborough, but forced its way out through the old entrance of the Ingleborough cave, breaking up the calcareous breccia, and removing the large stones in its course. A cave obviously may become dry, either by the drainage passing along a lower level, or by the elevation of the district by subterranean energy. After it has been forsaken by the stream, the particles brought down by the atmospheric water percolating through the joints, tend to fill it up on the surface, and these may be either of clay, loam, or sand.

These actions may be studied in this country in the well-known caves of Ingleborough, Buxton, Cheddar, Wookey Hole, and a great many others in Derbyshire, Yorkshire, Staffordshire, Durham, Cumberland, and Wales.

The Cave of Caldy.

Among the most beautiful stalactite caverns in this country is that on the island of Caldy, immediately opposite to Tenby in Pembrokeshire, discovered some

years ago in the limestone cliff, and explored by Mr. Ayshford Sanford and the Rev. H. H. Winwood, in 1866, and subsequently by the writer in 1871 and 1872. On creeping through a narrow entrance with an outlook to the sea on a precipitous side of a quarry, a passage leads to a chamber of considerable horizontal

FIG. 9.—A View in the Fairy Chamber, Caldy.

extent, the bottom being covered with silt, on which stand pedestals of dripstone from an inch to two feet in length, each rising from a thin calcareous crust

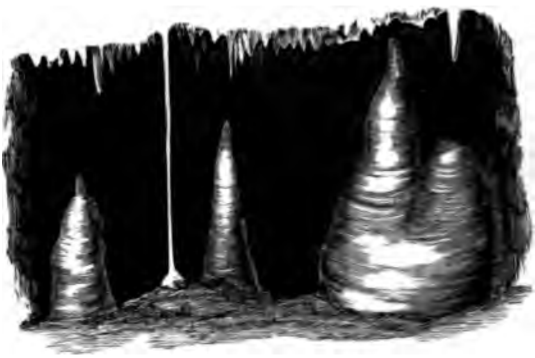


FIG. 10.—Stalagmites in the Fairy Chamber, Caldy.

which does not altogether conceal the silt below. From it a low entrance leads into a fairy-like chamber, the floor consisting of a rich red, crystalline pavement, perfectly horizontal, and studded here and there with round

bosses (Figs. 9, 10, 11), either red or snow-white. From the roof hang stalactites offering the same beautiful contrast of colours, forming a delicate canopy of tassels, or passing downwards to the floor and constituting slender shafts about three feet long, and about the diameter of

FIG. 11.—The Fairy Chamber, Caldy.

straws. Each of these is hollow, translucent, and more or less traversed by water, and in some places each stood next its fellow, almost as close as the straws in a corn-field. Sometimes the shaft stands on a cone (Fig. 11) of dripstone, more or less raised above the floor. Small pools of water occupy hollows in the pavement, each lined with glittering crystals of calcite (Fig. 12), which are slowly shooting over the surface, and converting some of the open hollows into bottle-shaped cavities

(Fig. 13). Their sides and bottoms are covered with a crystalline growth of singular beauty, of which an idea may be formed by woodcut 14, which represents the edge. Where the drip happened to fall into a shallow pool, it gradually built up for itself a cone, on the lower portion of which the varying water-level is marked by horizontal rings of crystals (Fig. 15), and the normal water-line by the upper horizontal plate. Sometimes these were united to the roof by a slender straw-shaft. In Figure 11 the original shaft has been broken away, and as the direction of the drip has slightly shifted, a new one gradually descended, until finally it became cemented to the side of the cone.

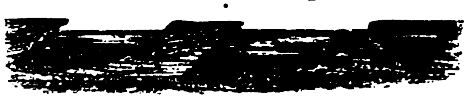


FIG. 12.—Pools in Fairy Chamber.

FIG. 13. — Pool in Fairy Chamber.

FIG. 14.—Edge of Pool in Fairy Chamber.

FIG. 15.—Cone with Straw-column.

The history of these structures is very evident. The straw-like stalactites were formed by the evaporation of the carbonic acid from the surface of each drop of water, as it accumulated in one spot, and the consequent

deposit of carbonate of lime around its circumference. It could not be formed in the centre, because of the continual movement of the successive drops in falling. By a circumferential growth of this kind a small crystal tube, of the diameter of a drop, is slowly developed, which continues to lengthen until the result is one of the straw-columns, with a hole in the centre for the passage of the water, which cannot readily part with its carbonic acid till it arrives at the end of the tube. Sometimes the hole has been subsequently blocked up by calc-spar, or the general surface been covered over with successive layers, until it becomes a mass of considerable diameter. If the drop fell into a deep pool, the straw-column was continued down to the water-line; if in shallow water, or on the floor, a pedestal was built up, as is represented in the preceding figures. The crystallization going on in the pools is greater at the surface than below, because of the greater evaporation, and consequently the stalagmitic film is gradually extending over it on every side from the edges (Figs. 12, 13).

As I broke my way into some of the unexplored recesses, through the thickly planted straw-shafts, and scene after scene of fairy beauty, unsullied by man, opened upon my eyes, the ringing of the fragments on the crystalline floor that accompanied almost every movement made me feel an intruder, and sorry for the destruction.

In some places, where the drip was continuous, and the calcareous basin which it had built up for itself shallow, small spherical bodies of calcite were so beautifully polished by friction in the agitated water, that they deserve the name of cave-pearls from their lustre. In Fig. 16 I have represented a tiny basin with its pearly

contents. Where the drip had ceased to be continuous each of these formed a nucleus for the deposit of calcite crystals, by which they were united to the bottom of the basin.

In the principal chamber in the cave, which is very nearly free from drip, the upper surfaces of the stones and stalagmites on the floor are covered with a peculiar fungoid-like deposit of calcite, consisting of rounded bosses, attached to the general surface by a pedicle (see Figs. 17, 18) sometimes not much thicker than a hair. They stood close together at various levels, following the inequalities of the surface of attachment, and being on an average about 0·2 inch long. Several microscopical sections (Fig. 17) showed that each was formed originally on a slight elevation of the general surface, which would cause a greater evaporation of water than the surrounding portions, and therefore be covered with a greater deposit of calcite. This process would go on until the height was reached to which the water slowly passing over the general surface would no longer rise. Hence the remarkable uniformity of the height of the bosses. The evaporation is greater at the point furthest removed from the general surface, and therefore the apex is larger than the base (see Fig. 17). In Figure 18 they stand

FIG. 16.—Basin containing Cave-pearls.

FIG. 17.—Fungoid Structures, magnified.

as thickly together as trees in a virgin forest, and are developed in greatest vigour where the small eminences cause a greater evaporation than the small depressions, and are stoutest and strongest at the free edges. Some of the pedicles, as in the figure, present traces of erosion, the outer layers having been eaten away by acid-laden water.

Some of these singular little bosses may have been moulded on minute fungi, such as those in the cave of Ingleborough, but their presence is not revealed by the microscope.

The Black-rock Cave, near Tenby.

I met with this remarkable kind of calcareous deposition in a second cave in the neighbourhood of Tenby. When examining the Black-rock quarries in 1871, the workmen pointed out a small opening which they believed to be the entrance of a cave, but which was too small for them to enter. By knocking off, however, a few sharp angles, I got into a small chamber about five feet high, with sides, roof, and bottom covered with massive dripstone. A few loose stones rested on the bottom. The whole surface, even including the stones upon the floor, one of which is figured (Fig. 18), was so completely covered with these peculiar fungoid bodies, that it was impossible to move without destroying hundreds of them. All were about the same height, 0·2 inches, snow-white,

FIG. 18.—Fungoid Structure, Black-rock Cave.

or of a rich reddish brown, and conformed to the unequal surface on which they stood. It is quite impossible to describe the effect of a whole chamber bristling with these peculiar structures. The only author by whom they are mentioned, Mr. John Beaumont—who described the caves of Mendip in 1680, considered them to be veritable plants of stone.[1] The beautiful forms assumed by the dripstone in the caves of Caldy and Black-rock are by no means uncommon, but I have never met with them anywhere else in such perfection. They may be studied in all stalactitic caverns.

Great Quantity of Carbonate of Lime dissolved by Atmospheric Water.

A small portion only of the carbonate of lime is deposited as tufa or dripstone in the neighbourhood of the rock from which it has been derived, as compared with that carried by the streams into the rivers, and the rivers into the sea. An idea of this quantity may be formed from the calculation of the solid matter conveyed down by the Thames, given by Mr. Prestwich in his Presidential Address to the Geological Society in 1871, p. lxvii.

"Taking the mean daily discharge of the Thames at Kingston at 1,250,000,000 gallons, and the salts in solution at nineteen grains per gallon, the mean quantity of dissolved mineral matter there carried down by the Thames every twenty-four hours is equal to 3,364,286 lbs., or 150 tons, which is equal to 548,230 tons in the year. Of this daily quantity about two-thirds, or say

[1] Phil. Trans. April 7th, 1680, p. 731.

1,000 tons, consist of carbonate of lime and 238 tons of sulphate of lime, while limited proportions of carbonate of magnesia, chlorides of sodium and potassium, sulphates of soda and potash, silica and traces of iron, alumina, and phosphates, constitute the rest. If we refer a small portion of the carbonates and the sulphates and chlorides chiefly to the impermeable argillaceous formations washed by the rain-water, we shall still have at least ten grains per gallon of carbonate of lime, due to the chalk, upper greensand, oolitic strata, and marlstone, the superficial area of which, in the Thames basin above Kingston, is estimated by Mr. Harrison at 2,072 square miles. Therefore the quantity of carbonate of lime carried away from this area by the Thames is equal to 797 tons daily, or 290,905 tons annually, which gives 140 tons removed yearly from each square mile; or, extending the calculation to a century, we have a total removal of 29,090,500 tons, or of 14,000 tons from each square mile of surface. Taking a ton of chalk, as a mean, as equal to fifteen cubic feet, this is equal to the removal of 210,000 cubic feet per century for each square mile, or of $\frac{9}{100}$ of an inch from the whole surface in the course of a century, so that in the course of 13,200 years a quantity equal to a thickness of about one foot would be removed from our chalk and oolitic districts."

This destructive action, operating through long periods of time, destroys not merely the general surface of the limestone, but, where it is localized by the convergence of water, is capable of excavating the deepest gorges and the longest caves. The quantity of material carried away in solution is a measure of the power of carbonic acid in the general work of denudation.

The Circulation of Carbonate of Lime.

The circulation of carbonate of lime in nature presents us with a never-ending cycle of change. It is conveyed into the sea to be built up into the tissues of the animal and vegetable inhabitants. It appears in the gorgeous corallines, nullipores, calcareous sea-weeds, sea-shells, and in the armour of crustaceans. In the tissues of the coral-zoophytes it assumes the form of stony groves, of which each tree is a colony of animals, and in the wave-defying reef it reverts to its original state of limestone. Or, again, it is seized upon by tiny masses of structureless protoplasm, and fashioned into chambers of endless variety and of infinite beauty, and accumulated at the bottom of the deeper seas, forming a deposit analogous to our chalk. In the revolution of ages the bottom of the sea becomes dry land, the calcareous *débris* of animal and vegetable life is more or less compacted together by pressure and by the infiltration of acid-laden rain-water, and appears as limestone of various hardness and constitution. Then the destruction begins again, and caves, pot-holes, and ravines are again carved out of the solid rock.

The Temperature of Caves.

The air in caves is generally of the same temperature as the mean annual temperature of the district in which they occur, and therefore cold in summer and warm in winter. This would be a sufficient reason why they should be chosen by uncivilized peoples as habitations.

The very remarkable glacières, or caves containing ice instead of water, in the Jura, Pyrenees, in Teneriffe, Ice-

land, and other districts of high altitude and low temperature, in which the temperature even in summer does not rise much above freezing-point, may be explained by the theory advanced independently by De Luc and the Rev. G. F. Browne. "The heavy cold air of winter," writes the latter, "sinks down into the glacières, and the lighter, warm air of summer cannot on ordinary principles dislodge it, so that heat is very slowly spread in the caves; and even when some amount of heat does reach the ice, the latter melts but slowly, since a kilogramme of ice absorbs 79° C. of heat in melting; and thus when ice is once formed, it becomes a material guarantee for the permanence of cold in the cave. For this explanation to hold good it is necessary that the level at which the ice is found should be below the level of the entrance to the cave; otherwise the mere weight of the cold air would cause it to leave its prison as soon as the spring warmth arrived." It is also necessary that the cave should be protected from direct radiation and from the action of wind. These conditions are satisfied by all the glacières explored by Mr. Browne.[1] The apparent anomaly that one only out of a group of caves exposed to the same temperatures should be a glacière, may be explained by the fact that these conditions are found in combination but rarely, and if one were absent there would be no accumulation of perpetual ice. It is very probable that the store of cold laid up in these caves, as in an ice-house, has been ultimately derived from the great refrigeration of climate in Europe in the Glacial Period.

[1] "Ice-Caves in France and Switzerland." Longmans, 1865, p. 296.

Conclusion.

In this chapter we have examined the physical history of caves, their formation, and their relation to pot-holes, cirques, and ravines; and we have seen that they are not the result of subterranean disturbance, but of the mechanical action of rain-water and the chemical action of carbonic acid, both operating from above. We have seen that cave-hunting is not merely an adventurous amusement, but also a quest that brings us into a great laboratory, so to speak, in which we can see the natural agents at work that have carved out the valleys and gorges, and shaped the hills wherever the calcareous rocks are to be found.

The rest of this treatise will be devoted to the evidence which they offer as to the former inhabitants, both men and animals, of Europe.

CHAPTER III.

HISTORIC CAVES IN BRITAIN.

Definition of Historic Period.—Wild Animals in Britain during the Historic Period.—Animals living under the care of Man.—Classificatory value of Historic Animals.—The Victoria Cave, Settle, Yorkshire.—History of Discovery.—The Romano-Celtic or Brit-Welsh Stratum.—The Bones of the Animals.—Miscellaneous Articles.—The Coins.—The Jewelry, and its Relation to Irish Art.—Similar Remains in other Caves in Yorkshire.—These Caves used as Places of Refuge.—The evidence of History as to Date.—Britain under the Romans.—The Inroads of the Picts and Scots.—The English Conquest.—The Neolithic Stratum.—The approximate Date of the Neolithic Occupation.—The Grey Clays.—The Pleistocene Occupation by the Hyænas.—The probable Preglacial Age of the Pleistocene Stratum.—The Kirkhead Cave.—Poole's Cave, near Buxton.—Thor's Cave, near Ashbourne.—Historic value of Brit-Welsh Group of Caves.—Principal Animals and Articles.—The use of Horse-flesh.—The Cave of Long-berry Bank.

Definition of Historic Period.

In the preceding chapter the origin of caves has been discussed, as well as their relation to the physical geography of the districts in which they are found. We must now pass on to the biological division of the subject, which relates to the animals that they contain and the inferences that may be drawn from their occurrence.

The caves will be divided into historic, prehistoric, and pleistocene, according to the principles laid down in the first chapter.

It is extremely difficult, if not impossible, to define with precision the point where legend ends and history begins; but the line may be drawn with convenience at the first beginning of a connected and continuous narrative, rather than at the first isolated notice of a country. If we accept this definition, the historic period in Great Britain cannot be extended further back than the temporary invasion of Julius Cæsar, B.C. 55, even if so far, since of the interval that elapsed between that event and the subjugation under Claudius, in the year A.D. 43, we know scarcely anything. Of the events which happened in this country before Cæsar's invasion there is no documentary evidence, although, by the modern method of scientific research, we are able to extend the narrative away from the borders of history far back into the archæological and geological past.

Wild Animals in Britain during the Historic Period.

During the historic period great changes have taken place in the animals inhabiting Great Britain. The wild animals have been diminished in number, and their area of occupation has been narrowed by the increase of population and the improvement in weapons of destruction. The brown bear, inhabiting Britain during the time of the Roman occupation, was extirpated probably before the tenth century. The current belief that it was destroyed in Scotland by the founder of the Gordon family in 1057 is unsupported by any documentary evidence which I have been able to discover;

the crest of the Gordons, which is supposed to have been derived from the last of those animals slain in the island, consisting of three boars', not *bears'*, heads. The last wolf is said to have been destroyed in Scotland in 1680, while in Ireland the animal lingered thirty years later to be a terror to the defenceless beggars. It was deemed worthy of a special decree for its destruction in the reign of Edward I. The wild boar was extinct before the reign of Charles I., while the beaver, which was hunted for its fur on the banks of the Teivi in Cardiganshire during the time of the first Crusade, became extinct shortly afterwards. The stag was so abundant in the south of England as recently as the reign of Queen Anne, that she saw a herd of no less than five hundred between London and Portsmouth. At present the animal lives only in a half-wild condition, in the forest of Exmoor and the Highlands of Scotland; while the roedeer is now only found wild in Scotland, although it formerly ranged throughout the length and breadth of the country.

The reindeer is proved to have been living in Caithness as late as the year 1159, by a passage in the Orkneyinga Saga.

The common rat, *Mus decumanus*, is the only wild or semi-wild animal that has migrated into this country during the historic period contrary to the will of man. In 1727 it (*Pallas, Glires*) had begun to invade Southern Russia from the regions of Persia and the Caspian Sea. Thence it swiftly spread over Asia Minor, and while it was advancing to the west overland, it was carried by ships to nearly all the ports in the world. It arrived in Britain certainly before the year 1730, and has since nearly exterminated the black

indigenous species. It is the only wild animal which is known to have invaded Europe since the pleistocene age, with the exception, perhaps, of the true elk.

Animals living under the care of Man.

The fallow-deer, indigenous in the countries bordering on the Mediterranean, was probably introduced by the Romans, since its remains occur in refuse-heaps of Roman age, such as that of London Wall, and of Colchester, while it has not been met with in older deposits. To them, also, we probably owe the introduction of the pheasant, which was sufficiently abundant in the neighbourhood of London in the time of Harold to be mentioned as one of the articles of food eaten on feast-days by the households of the Canons at Waltham Abbey in 1059. The domestic fowl has left the first traces of its presence in this country in the Roman refuse-heaps, although it was known to the Belgæ, according to the testimony of Cæsar, before the first Roman invasion.

The earliest mention of the domestic cat in this country is to be found in the laws of Howel Dha,[1] that were probably codified at the end of the tenth or in the eleventh century, although many of the enactments may be of a much earlier date. The king's cat is assessed at eightpence, or twice as much as that belonging to any subject. The ass[2] was certainly known in Britain in the days of Æthelred (A.D. 866–871), when, according to Professor Bell, its price was fixed at the large sum of twelve shillings. The larger breed of cattle represented by the Chillingham ox, and descended from the great Urus,

[1] Leges Walliæ.

[2] Bell, "British Quadrupeds," 8vo. p. 386.

first appears in this country about the time of the English invasion. It gradually spread over those districts conquered by the English, until the small aboriginal dark-coloured, short-horn *Bos longifrons*, which was the only domestic breed in the prehistoric and Roman times, is now only to be met with in the hill country of Wales and of Scotland, in which the Brit-Welsh or Romano-Celtic inhabitants still survive.

Classificatory value of Historic Animals.

The principal changes in the fauna of Great Britain during the historic age are the extinction of the bear, wolf, beaver, reindeer, and wild boar, and the introduction of the domestic fowl, the pheasant, fallow-deer, ass, the domestic cat, the larger breed of oxen, and the common rat; and as this took place at different times, it is obvious that these animals enable us to ascertain the approximate date of the deposit in which their remains happen to occur. And for this purpose the following table[1] may be consulted:—

ANIMALS EXTINCT.

		A.D.
Brown bear	circa	500—1000
Reindeer	,,	1200
Beaver.	,,	11—1200
Wolf	,,	1680
Wild boar	,,	1620

[1] The authorities for the preceding paragraphs will be found in Chapter II. of my Preliminary Treatise on the "Relation of the Pleistocene Mammalia to those now living in Europe" (Palæont. Soc. 1874).

ANIMALS INTRODUCED.

Domestic fowl	before	55 B.C.
Fallow-deer	circa	,,
Pheasant	,,	,,
Domestic ox of Urus type . .	,,	449 A.D.
Ass	,,	800—850
Cat	,,	800—1000
Common rat	,,	1727—30

Some or other of these animals are met with in the peat-bogs and alluvia, and in caves, but far more abundantly in the refuse-heaps left behind by man, by whom they have here been used either for service or for food.

The disappearance of certain wild species, from the areas in which they lived on the continent, in historic times, has not been ascertained so accurately as in this country, and many animals, which have become extinct in our restricted and highly-cultivated island, are still to be found in the continental forests, morasses, and mountains. The brown bear is still to be met with in the Pyrenees, the Vosges, and in the wilder and more inaccessible portions of northern, middle, and southern Europe. The wolf still survives in France, and during the late German war preyed upon the slain after some of the battles. It, as well as the wild boar, ranges throughout the uncultivated regions of the continent. The beaver still lives in the waters of the Rhone, as well as in the rivers of Lithuania and of Scandinavia, and the reindeer, now restricted to the regions north of a line passing east and west through the Baltic, extended further south, in sufficient numbers to be remarked by Cæsar, among the more noteworthy animals living in the great Hercynian forest, which overshadowed northern Germany in his days. This forest also afforded shelter to the true elk

and the bison, both of which still live in Lithuania, as well as to the Urus, which was hunted by Charles the Great, near Aachen, and probably became extinct in the fifteenth or sixteenth century. The lion inhabited the mountains of southern Thrace in the days of Herodotus and of Aristotle, and became extinct in Europe between 330 B.C. and the days of Dio Chrysostom Rhetor (A.D. 100), who expressly says that there were no lions in Greece in his time. The panther also inhabited the same district when Xenophon wrote his "Treatise on Hunting."

The fallow-deer was believed by the late Professor Edouard Lartet to have been introduced into France by the Romans. On a visit, however, to Paris in September 1873, Professor Gervais called my attention to an antler of the animal in the Jardin des Plantes, said to have been found in a refuse-heap along with axes of polished stone. It must therefore have lived in France in the Neolithic age, if it were obtained from an undisturbed deposit. It gradually spread into Germany and Switzerland, until in the eleventh century it was sufficiently abundant to be mentioned among the articles of food in a metrical grace of the monks of St. Gall.

"Imbellem damam faciat benedictio summam." [1]

The domestic fowl is to be recognized on Gallic coins before the Roman invasion, and therefore was probably known at the very dawn of Gallic history. The larger breed of oxen, descended from the Urus type, has been known in France, Germany, Lombardy, Scandinavia, and Switzerland, in the remote division of the pre-

[1] Benedict. ad Mensas Ekkehardi Monachi Sangallensis, l. 129.

historic age known as the Neolithic.[1] The buffalo, on the other hand, of the Roman Campagna, was introduced into Italy, according to Paulus Diaconus, in the year 596, and the domestic cat,[2] known to the Greeks from their intercourse with Egypt, became familiar to the eyes of the inhabitants of Rome and Constantinople as early as the fourth century after Christ.

It is evident from the survival of the wolf, the bear, beaver, reindeer, and the wild boar on the continent at the present time, that the chronological table which I have constructed for Britain is inapplicable to Europe in general. In the present state of our knowledge of the varying ranges of the animals, it seems impossible to form any similar scheme.

The historic caves are characterized by the presence of some of these animals, as well as of coins and pottery, and other articles by which the date of their occupation may be ascertained.

The Victoria Cave, Settle, Yorkshire.

The most important historic cave in this country is that discovered by Mr. Joseph Jackson, near Settle, in Yorkshire, on the coronation day of Queen Victoria, in 1838, and which has therefore been called the Victoria Cave. It runs horizontally into the precipitous side of a lonely ravine known as King's Scar (Fig. 19), at a height of about 1,450 feet above the sea, according to Mr. Tiddeman, and it consists of three large ill-defined chambers filled with débris nearly up to the roof.

[1] Buffon, Quadrupeds, l. v. p. 52; l. x. p. 67. Sir G. C. Lewis, "Notes and Queries," 2nd series, l. ix. pp. 4, 5.

[2] See Rolleston, Journ. Anat. and Phys., 1868, pp. 51-2. Lenz, "Zoologie der Alten."

The entrances face to the south-west, and open at the bottom of an overhanging cliff at the point where a scree, or accumulation of fragments from the cliff above, gradually slopes down to the bottom of the valley, about one hundred feet below. When Mr.

FIG. 19.—View of King's Scar, Settle, showing the entrances of the Victoria and Albert Caves (from a photograph). A, B, Albert; C, Victoria.

Jackson made his discovery, he passed inwards through a small entrance,[1] and was rewarded by finding in the earth on the floor a number of Roman coins, together

[1] Fig. 19, A.

with ornaments and implements of bronze, and some brooches of singular taste and beauty, with implements of bone, and large quantities of broken bones and fragments of pottery. The collection was very miscellaneous; for besides iron spear-heads, nails, daggers, spoon-brooches of bone, spindle-whorls, beads of amber and of glass, there were bronze brooches, finger-rings, armlets, bracelets, buckles, and studs. All were lying pêle-mêle together, side by side with the broken bones of the animals, and the whole set of remains, with the exception of some of the brooches, was of the kind which is usually met with in the neighbourhood of Roman camps, cities, and villas which have been sacked.

The fragments of Samian ware and Roman pottery scattered through the mass, as well as coins of Trajan and Constantine, proved further, that the cave had been inhabited after the Roman invasion, and not earlier than the middle of the third century; and the rude imitations of Roman coins were, according to Mr. Roach Smith,[1] probably in circulation for some centuries after the departure of the Romans from Britain.—"And although some of these remains are indicative of sepulture, yet from the evidence furnished there appears no positive proof of their having formed part of funereal deposits. A more satisfactory conclusion seems to arise in considering that these caves (*i.e.* the group) may have been used as places of refuge by the Romanized Britons during the troublous times at and after the close of the fourth century." This conclusion we shall see fully borne

[1] Roach Smith, "Collectanea Antiqua," vol. i. No. 5, p. 72, 1844. It is noticed by Eckroyd Smith, Trans. Historic Society of Lancashire and Cheshire, May 11, 1865; and by Mr. Denny, Trans. Geol. and Polytechnic Soc. of West Riding, 1859.

out by the evidence subsequently obtained. Mr. Jackson gives the following account of the discovery :—

"The entrance was nearly filled up with rubbish, and overgrown with nettles. After removing these obstructions, I was obliged to lie down at full length to get in. The first appearance that struck me on entering was the large quantity of clay and earth, which seemed as if washed in from without, and presented to the view round pieces like balls of different sizes. Of this clay there must be several hundred waggon loads, but abounding more in the first than in the branch caves. In some parts a stalagmitic crust has formed, mixed with bones, broken pots, &c. It was on this crust I found the principal part of the coins, the other articles being mostly imbedded in the clay. In the other caves very little has been found. When we get through the clay, which is very stiff and deep, we generally find the rock covered with bones, all broken and presenting the appearance of having been gnawed. The entrance into the inner cave has been walled up at the sides. In the inside were several large stones lying near the hole, any one of which would have completely blocked it up by merely turning the stone over. I pulled the wall down, and the aperture was now about a yard wide, and two feet high. On digging up the clay at about nine or ten inches deep, I found the original floor ; it was hard and gravelly, and strewed with bones, broken pots, and other objects. The roof of the cave was beautifully hung with stalactites in various fantastic forms and as white as snow."[1]

The interest in these discoveries led Mr. Denny, Mr. Farrer, and other gentlemen to examine the superficial

[1] "Collectanea Antiqua," vol. i. No. 5, pp. 69, 70.

stratum from time to time, until, in 1870, Sir James Kay-Shuttleworth, Mr. Walter Morrison, Mr. Birkbeck, and other gentlemen in the neighbourhood formed a committee for the investigation of the contents of the cave, which had been placed at their disposal by the courtesy of the owner, the late Mr. Stackhouse. They were aided by the assistance of Sir C. Lyell, Sir. J. Lubbock, and Mr. Darwin, Professor Phillips, Mr. Franks, and others, and by a grant obtained from the British Association, and have carried on the work since that time with comparatively little interruption. Mr. Jackson, the original discoverer, superintended the workmen; while I identified the works of art and the mammalian remains that were discovered, and drew up for the committee the reports brought before the British Association in 1870, 1871, and 1872, and before the Anthropological Institute in 1871. Mr. Tiddeman also contributed a report on the physical history of the cave, which is printed in the British Association Report for 1872, and subsequently in the Geological Magazine, January 1873.[1]

[1] The Victoria Cave has engaged the attention of the following writers:—Farrer, Proceed. Soc. Antiquaries, vol. iv.;—Roach Smith and Jackson, "Collectanea Antiqua," vol. i. No. 5, 1844;—Denny, Proceed. Geol. and Polytechnic Society of the West Riding of Yorkshire, 1859;—Eckroyd Smith, Trans. Historic Society of Cheshire, May 11, 1865;—Boyd Dawkins, "Nature," April 21, 1870; British Assoc. Reports, 1870; Macmillan's Magazine, Sept. 1871; Journ. Anthrop. Institute, 1871;—Tiddeman, "Nature," 1872;—Boyd Dawkins and Tiddeman, British Assoc. Reports, 1872;—Tiddeman, Geol. Mag., Jan. 1873;—Boyd Dawkins, Proceed. Manch. Philosophical Soc., Feb. 1873;—Brockbank, Proceed. Manch. Philosophical Soc., March 1873.

The Romano-Celtic or Brit-Welsh Stratum.

The committee resolved not to begin at the entrance which Mr. Jackson discovered in 1838 (Fig. 19 A), but to make a new passage, at a point where daylight could be seen through the chinks of the broken débris, which there prevented access. Ground was broken on a small plateau in front of this (Figs. 19 B, 20), which, from the sunny aspect and commanding view, would naturally be

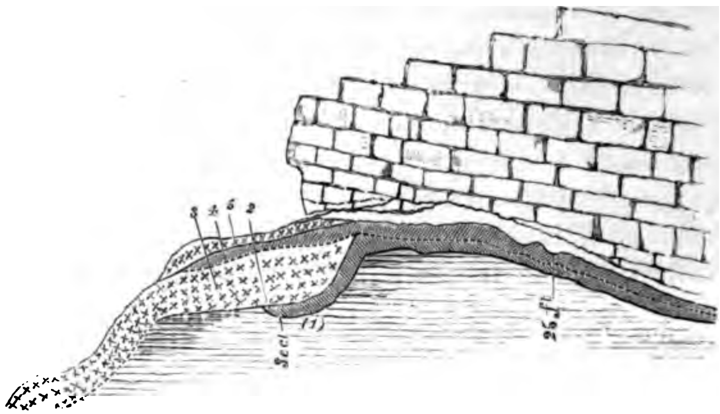
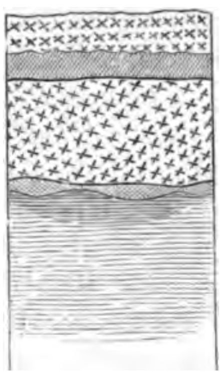


FIG. 20.—Longitudinal Section of Victoria Cave.

chosen by the dwellers in the cave as their more usual place for eating and lounging, and in which we might therefore expect to find the remains of whatever they had dropped or lost. The gloomy recesses of a cave, indeed, even if lit up by large fires or by torches, are not fitted for any other purpose than for sleeping or concealment; and if we add in this case the damp cold clay under foot and the constant drip of the water over-head, it was only reasonable to infer that most of their life was spent out of doors, and that the cave was used merely as a place of retirement for shelter. As the

trench progressed we dug first of all through a thickness of two feet (Figs. 20, 21) of angular blocks of limestone, that had fallen from the cliff above, and that rested on a black layer (No. 4) containing the kind of remains which we had expected. The layer was composed of fragments of bone and charcoal, surrounding the burnt stones which had formed the ancient hearths, and contained large quantities of the broken bones of animals which had been used for food, and coins and articles of luxury, as well as those instruments which were more naturally suited for the half-savage life of dwellers in caves. As we opened out the new mouth, the angular



5. Post-Roman Talus	Thickness, 2 feet.
4. Romano-Celtic Stratum, or Brit-Welsh	,, 2 ,,
3. Talus	,, 6 ,,
2. Neolithic Horizon	
1. Grey Clay	,, 4 to 6 feet.

FIG. 21.—Vertical Section at the Entrance to the Victoria Cave.

fragments disappeared and the black layer rose to the surface, composing the floor, and lying in some places beneath enormous blocks of limestone which had fallen from the roof since its accumulation, and being continuous with the layer in which Mr. Jackson first made his discoveries.

It was evident that this stratum had been formed during the sojourn of man in the cave, and we shall

find, in the examination of the remains which it furnished, proof that it is connected with the obscure history of Britain during the fifth and sixth centuries. We will take each group of objects in its proper class, beginning with what at first sight seems the least promising, the broken bones of the animals that supplied the inhabitants with food.

The Bones of the Animals.

The bones of the Celtic short-horn (*Bos longifrons*) were very abundant, and proved that a variety of ox, indistinguishable from the small dark mountain cattle of Wales and Scotland, was the chief food of the inhabitants. A variety of the goat with simple recurved horns, which is commonly met with in the Yorkshire tumuli explored by Canon Greenwell, and in the deposits round Roman villas in Great Britain, furnished the mutton; while the pork was supplied by a domestic breed of pigs with small canines; and since the bones of the last animal belong for the most part to young individuals, it is clear that the young porker was preferred to the older animal. The bill of fare was occasionally varied by the use of horse-flesh, which formed a common article of food in this country down to the ninth century. To this list must be added the venison of the roedeer and stag, but the remains of these two animals were singularly rare. Two spurs of the domestic fowl, and a few bones of wild duck and grouse, complete the list of animals which can with certainty be affirmed to have been eaten by the dwellers in the cave. The numerous unbroken bones, some very gigantic, of the badger, and those of the fox, wild-cat, hare, and water-vole, commonly called water-rat.

have probably been introduced subsequently, from those animals having used the cave as a place of shelter. There were also bones of the dog, which from their unbroken condition proved that the animal had not been used for food, as it certainly was used by the men who lived in the caves of Denbighshire in the Neolithic age. The whole group of remains implies that the dwellers in the Victoria Cave lived upon their flocks and herds, rather than by the chase. And since the domestic fowl was not known in Britain until about the time of the Roman invasion, the presence of its remains fixes the date of the occupation as not earlier than that time. On the other hand, since the small Celtic short-horn (*Bos longifrons*) was the only domestic ox in use known in Roman Britain, and since it disappeared from those portions of the country which were conquered by the English, along with its Celtic possessors, the date is fixed in the other direction as being not much later than the Northumbrian conquest of that portion of Yorkshire. I shall return to this part of the subject presently; here I will only remark, that the present distribution of the lineal descendants of the Celtic short-horn, the small, dark-coloured Scotch and Welsh cattle, corresponds with those regions on which the Celtic population fell back before the English. And its survival in Wales, and until comparatively recently in Cornwall, Cumberland, and Westmoreland, may be accounted for by the fact, that in those districts the Celtic populations of Roman Britain were not displaced by the English invaders.[1]

The larger breed of cattle known in its purity as the

[1] See Palæont. Society, 1874—Boyd Dawkins' Preliminary Treatise, Chapter II.

white ox of Chillingham, from which all our purely English breeds have been derived, was imported originally by the English, and spread over the whole country which they occupied, until at last the smaller and more ancient oxen survived only in a few isolated areas in the north and west of Britain. This displacement of the Celtic short-horn by the English oxen of the Urus type corroborates, in a striking degree, the truth of Mr. Freeman's view of the ruthless destruction of everything Roman and Celtic at the hands of the English. It is clear, therefore, that from the examination of the bones we may infer that the cave was occupied before the Celtic short-horn was supplanted in this district by the larger domestic breed of oxen, and after the introduction of the domestic fowl, that is to say, in the interval which elapsed between the Roman and English invasions.

We must now treat of the remains of man's handiwork in the cave.

Miscellaneous Articles.

The ornaments and implements of bone consist of carefully smoothed pins, and points intended to be fitted to a handle, knife-handles made of bone and antler; three spindle-whorls made of the perforated head of a femur; a stud; a perfect spoon-shaped fibula (Fig. 22), which corresponds with one of those in the Museum of the Royal Irish Academy, as well as several fragments, and which when in use was passed through holes in the clothes, in such a manner that the two ends alone were visible. These are ornamented, and the shaft and the whole back is more or less polished by wear. Eight articles bear a close resemblance to the handles of gimlets (Figs. 23, 24), and most probably have been

used as studs, or links, for fastening together clothing. The fact, indeed, that some have the central hole worn by the friction of a thong or string of some kind, coupled with the worn state of some of their surfaces, renders this guess very likely to be true. In Fig. 24, *a*, the ornament in right lines, which once covered the surface as in Fig. 24, *b*, is very nearly obliterated by friction against some soft body such as clothing. A reference to the figures will give a better idea of their shape and ornamentation than a mere description. Two perforated discs may have been used as studs. There are also many nondescript articles, consisting of sockets made of antler of stag, and bone rods carefully rounded, together with cut bones of uncertain use. For the identification of the ivory boss of a sword-hilt I am indebted to the kindness of Mr. Franks.

Fig. 22.—Spoon-brooch (natural size).

Besides the ornaments in bone and antler, there were seven glass beads, five transparent and two of a bluish tint, and one of jet turned in a lathe; as well as a fragment of a jet bracelet. Among the articles of daily use were many rounded pebbles, with marks of fire upon them, which had probably been heated for the purpose of boiling water. Pot-boilers, as they are called, of this kind are used by many savage

peoples at the present day, and if we wished to heat water in a vessel that would not stand the fire, we should be obliged to employ a similar method. Other stones formed parts of ancient hearths, and two or three grooved slabs of sandstone had evidently been used

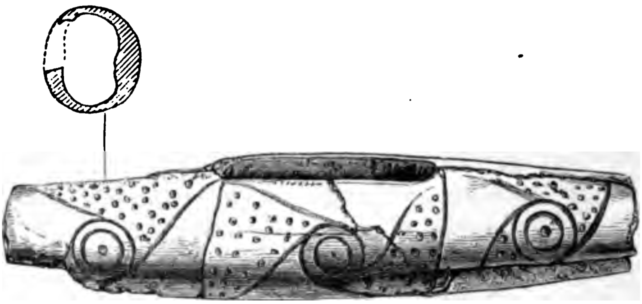


FIG. 23. –Ornamented Bone-fastener (natural size).

for rounding and sharpening bone pins. The fragments of pottery were very abundant, and were all of the type usually found round Roman villas. One fragment of

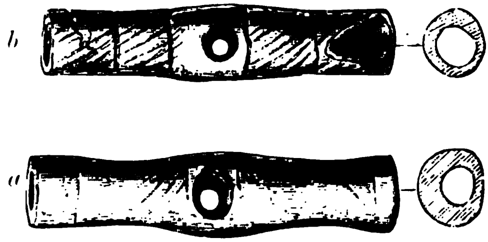


FIG. 24.—Two Bone-links; *a* worn, *b* unworn (natural size).

Samian ware was ornamented with the representation of a hunt.

This group of articles throws but little light on the date of the occupation of the cave. The Samian ware, and the ivory boss of a Roman sword, merely imply that it was either Roman or post-Roman.

The Coins.

If we turn now to the coins, we shall find the date to lie within narrower limits than those fixed by the animals. They consist of:—

Two silver of Trajan, d. 117.
Four bronze of Tetricus I., } 267—274.
One bronze of Tetricus II., }
One bronze of Gallienus, d. 268.
One bronze of Constantine II., d. 343.
One bronze of Constans, d. 353.
Three barbarous imitations in bronze of coins of Tetricus, circa 400—500 A.D.

In a group of coins such as this the latest only give a clue to the date, since the earlier may have remained in circulation long after they were struck. In India, for example, those of Alexander the Great have not yet disappeared from the country, and in Spain, in the shops of Malaga, Moorish, Roman, and even Phœnician coins were current in 1863, as well as all those which have been struck since.[1] We may therefore disregard the earliest coins, and fix our attention more particularly on those of the Constantine family, and the bronze minimi mentioned last in the list. The presence of the coin of Constans implies that the cave was occupied either during or after 337 A.D., when he ascended the throne; while the date of the minimi has not been ascertained with accuracy. "They abound upon all Roman sites, such as Verulam and Richborough. In size they come nearest to those struck under Arcadius and his successors, and I think that you will not be far wrong in assigning them to the first half of the fifth century.

[1] R. D. Darbishire, Proceed. Manchester Numismatic Society, Part II. 1865: "On some Autonomous Coins of Ancient Spain."

The latest of the genuine Roman coins found in this country are those of Arcadius and Honorius; at least, the finding of any of later date is quite exceptional. What the currency was between that time and the commencement of the Saxon coinage it is hard to say. It seems probable, however, that gold and silver had nearly disappeared, and that the needs of a small local commerce were supplied by the Roman copper coins of which abundance remained in the country, and by small pieces struck after their model, not improbably by private speculators." This opinion, which Mr. John Evans, F.R.S., has been kind enough to write me, coincides with that of Mr. Newton, as well as that of Mr. Roach Smith; and we may therefore assume, with tolerable certainty, that the cave was inhabited during the first half of the fifth century or afterwards, at a time when the withdrawal of the Roman Legions had left the colony of Britain, whose youth and vigour had been consumed in the fierce struggle of the rivals for the throne of the West, a prey to the barbarian invaders.

It is of course conceivable that some of these coins may have been dropped at one time, and some at another, but nevertheless it seems very probable that the whole accumulation belongs to the same relative age. But whether this be accepted or not, it is certain the cave was inhabited during the time that the minimi were in circulation,—that is to say, during the first half of the fifth century, or from that time forwards.

The Jewellery, and its Relation to Irish Art.

This conclusion as to the date, derived from the coins, is confirmed in a remarkable degree by the examination of the articles of luxury. Besides two bronze brooches

of the Roman pattern, known by archæologists as harp-shaped (Coloured Plate, fig. 5), was one of the split-ring type, with a moveable pin, which is generally assigned to the later period of the Roman occupation of this country. One type of brooch was composed of two circular plates of bronze, soldered together, the front being very thin and bearing flamboyant and spiral patterns in relief (Fig. 25), of admirable design and execution. The original of the figure was discovered by Mr. Jackson, and is more perfect than any of those which we obtained in our excavations. It is altogether unlike any Roman brooch properly so called, both in its composite make and style of ornament. A similar brooch has been discovered at Brough Castle, in Westmoreland, and was figured in the Proceedings of the Antiquarian Society (vol. iv. 129), by Sir James Musgrave, and a second is preserved in the Museum of the Royal Irish Academy (492). The style corresponds with that of a medallion on a Runic casket of silver-bronze, figured by Prof. Stevens, and stated to have been obtained from Northumbrian Britain, as well as that of a brooch in the Museum at Mainz, assigned by the same authority to the third or fourth century. It is also to be met with in the illuminations of one of the Anglo-Saxon Gospels at Stockholm, as well as in those of the Gospels of S. Columban, preserved in the library of Trinity College, Dublin, and in the "Book of Kells" (8–900).[1] In all these cases it cannot be

FIG. 25.—Bronze Brooch (natural size).

[1] Vetusta Monumenta, vol. vi.

affirmed to be Roman, and it is not presented by ornaments of either purely English or Teutonic origin. It is most closely allied to that work which is termed by Mr. Franks "late Celtic." From its localization in Britain and Ireland, it seems to be probable that it is of Celtic derivation; and if this view be accepted, there is nothing at all extraordinary in its being recognized in the illuminated Irish Gospels. Ireland, in the sixth and seventh centuries, was the great centre of art, civilization, and literature; and it is only reasonable to suppose that there would be intercourse between the Irish Christians and those of the west of Britain during the time that the Romano-Celts, or Brit-Welsh, were being slowly pushed to the westward by the heathen English invader. Proof of such an intercourse we find in the brief notice in the "Annales Cambriæ," in which Gildas, the Brit-Welsh historian, is stated to have sailed over to Ireland in the year A.D. 565. It is by no means improbable that about this time there was a Brit-Welsh migration into Ireland, as well as into Brittany.

Nor is it at all strange that the same style of ornament should occur in some few cases in North Germany. "The conquest of Britain," writes the Rev. J. R. Green ("History of the English People," p. 16[1]), "had thrust a wedge of heathendom into the heart of the Western Church. On the one side lay Italy and Gaul, whose Churches owned obedience to the see of Rome, on the other the free Celtic Church of Ireland. But the condition of the two portions of Western Christendom was very different. While the vigour of Latin Christianity was exhausted in a bare struggle for life, Ireland

[1] I have to thank the Rev. J. R. Green for allowing me to quote this passage from his work, which is now in the press.

as yet unscourged by invaders had drawn from its conversion an energy such as it has never known since. Christianity had been received there with a burst of popular enthusiasm. Letters and arts sprang up rapidly in its train; the science and Biblical knowledge which had fled from the continent took refuge in famous schools which made Durrow and Armagh the universities of the West. The new life soon beat too strongly to brook confinement within insular bounds. Patrick, the first missionary of Ireland, had not been half a century dead, when Celtic Christianity flung itself with a fiery zeal into battle with the mass of heathenism which had rolled in upon the Christian world. Irish missionaries laboured among the Picts of the Highlands, among the Frisians of the northern seas; Columban founded monasteries in Burgundy and the Apennines; the canton of St. Gall still commemorates in its name the missionary before whom the spirits of flood and fell fled wailing over the waters of the Lake of Constance. For a time it seemed as if the course of the world's history was to be changed, as if the older race that Roman and Teuton had swept before them had turned to the moral conquest of its conquerors, as if Celtic and not Latin Christianity was to mould the destinies of the Churches of the West."

It is impossible that Irish-Celtic art should not have made itself felt wherever the Irish missionaries penetrated, and especially in the gorgeous illuminated Gospels, which it was the pride of S. Columban and his school to have made, and which now excite our wonder and admiration. The early Christian art in Ireland grew out of the late Celtic, and was, to a great extent, free from the influence of Rome, which

is stamped on the Brit-Welsh art of the same age in this country. The style, therefore, of these circular brooches, from its correspondence with that of the Irish illuminated gospels, affords reasonable grounds for the belief that the Victoria Cave was inhabited in the sixth century, or possibly later, but before the English invaders had swept the Brit-Welsh away from the district.

Two other brooches were also discovered in the black layer, which are even of greater interest than those which have just been described. The one represents a dragon (colored Plate, fig. 3), with its eye made of red enamel; the other (colored Plate, fig. 7) shaped, like the letter S, has its front composed of an elaborate cloissonnée pattern in red, blue, and yellow enamels, and is of the same design as two brooches in the British Museum, discovered, one near Whittington Hill, in Gloucestershire, and the other near Malton, in Yorkshire. All three were, undoubtedly, turned out of the same artistic school, and they may have been made by one workman. The enamel, in all these examples, seems to have been inserted into hollows in the bronze, and then to have been heated so as to form a close union with them, and in some cases where it has been broken, as in colored Plate, fig. 7, small fragments still remain to attest the completeness of the fusion with the bronze. The style of workmanship is neither Roman nor Teutonic. An enamelled fibula with spirals in relief, found at Reichenbach[1] (Soleure) in a post-Roman sepulchre, and figured by Bonstettin, is of a similar design, and it may be traced also in two brooches obtained by the Abbé Cochet, from the Merovingian Cemetery of

[1] Antiquités Suisses, Second Supplement; Lausanne, 1867, p. 15, Pl. xii. figs. 3, 4.

Envermeu,[1] although they are of more massive and square construction than those of Yorkshire.

One harp-shaped brooch (colored Plate, fig. 1) is ornamented with diamonds of blue enamel, separated by small triangles of red, and shows in its Roman design and Celtic ornamentation the union between Celtic and Roman art. A similar specimen from Brough Castle, Westmoreland, is preserved in the British Museum, and may have been turned out of the same workshop. We also met with an enamelled disk (colored Plate, fig. 6), and a finger-ring (fig. 4) of bronze-gilt, ornamented with blue enamel.

Several enamelled fibulæ in the British Museum, obtained by Sir James Musgrave, at Kirby Thore, Westmoreland, belong to the same style of art as those of the Victoria cave, and were associated with the same class of remains. Shields,[2] scabbards, horse trappings, and other articles have also been discovered in this county, decorated in the same fashion with coloured enamels, and especially a bronze vase from the late Roman tumuli, called the Bartlow Hills. They all belong to the class termed "late Celtic" by Mr. Franks, and are considered by him to be of British manufacture.

This view is supported by the only reference to the art of enamelling which is furnished by the classical writers. Philostratus, a Greek sophist, who left Athens in the beginning of the third century to join the Court of Julia Domna, the wife of the Emperor Severus, writes:—"It is said that the barbarians living in or by the ocean, pour these colors (those of the horse trap-

[1] La Seine Inférieure, 4to., 1867, p. 203.

[2] See Kemble, "Horæ Ferales," 4to.; Description of Plates by A. W. Franks, p. 64.

pings) on heated bronze, that these adhere, grow as hard as stone, and preserve the designs that are made in them."[1] Mr. Franks' opinion that this passage relates to Britain, seems to be more probable than that of the eminent French archæologist, M. de Laborde, who holds that it relates to Gaul and especially to "Belgica."[1]

When we consider the variety of enamelled objects which have been discovered in the north of England, it seems to be by no means improbable that the principal centre of the art enamelling was here rather than in the south; and this conclusion is considerably strengthened by the fact that under the Romans political power centered in the district between the Humber and the Tyne, and that York, and not London, was the capital of Britain and the seat of the Roman Prefect. It is worthy of remark, that since the Emperor Severus built the wall which bears his name, marched in person against the Caledonians, and died at York, the account of the enamels may have been brought to the court of the Empress Julia from this very region, and thus come to be recorded by Philostratus.

Two harp-shaped fibulæ, obtained by Mr. Jackson from the Victoria cave, and ornamented with enamel, are coated with silver, and in one of them two small blocks of that metal still remain firmly imbedded in the bronze. It is very probable that most of the ornaments were plated either with silver or gold, traces of which, in some cases, still remain.

Among the miscellaneous objects in metal are a bronze

[1] ταῦτα φασι τὰ χρώματα τοὺς ἐν Ὠκεανῷ βαρβάρους ἐγχεῖν τῷ χάλκῳ διαπύρῳ, τὰ δὲ συνίστασθαι καὶ λιθοῦσθαι, καὶ σώζειν ἃ ἐγράφη (Icon. lib. i. c. 28). The art was evidently unknown in Rome at this time.

[2] Notice des Émaux du Musée du Louvre, 1857, pp. 25, 26.

wire brooch (colored Plate, fig. 8), two bracelets, composed of twisted bronze-gilt wire; and one fragment in solid bronze, ornamented with right lines; one plain bronze finger-ring; two small buckles, respectively of bronze and of iron, and a small bronze flattened pin (colored Plate, fig. 2), ending in two points to which, at first, we were unable to assign a use. When, however, the two points were compared with the circles on the ornaments of bone (Fig. 22), there was but little doubt that this curious object was employed as a pair of fixed compasses. There were also iron articles which were too much corroded to admit of a guess at their probable use, besides a Roman key, knife-blades, and a spear-head discovered by Mr. Jackson.

The number of ornaments found in the Victoria Cave from time to time by various explorers is very considerable. They are scattered in the private collections of Messrs. Jackson and Eckroyd Smith, and in the Museums of Giggleswick Grammar-school, and of Leeds, and the British Museum.

Similar remains in other Caves in Yorkshire.

The Victoria cave is by no means the only one in the district that has furnished works of art and the remains of animals. The Albert cave (Fig. 19, *c.*) close by is, as yet, only explored sufficiently to prove that it contains the same kind of objects; and from that of Kelko, overlooking Giggleswick, they have been obtained by Mr. Jackson;[1] as well as from that of Dowker-bottom between Arncliffe and Kilnsay, by Mr. James Farrer and Mr.

[1] Eckroyd Smith, Trans. Hist. Soc. Lancashire and Cheshire, 1866. Limestone Caves of Craven.

Denny.[1] From the last, seven spoon-shaped brooches of bone, and two spindle-whorls of Samian ware of the bottom of a vase, are preserved in the British Museum, as well as a bronze needle, and brooches both harp-shaped and discoid, and fragments of pottery. Three coins in bronze, according to Mr. Farrer,[2] prove that the date of the accumulation is late or post-Roman, one being of Claudius Gothicus, whose reign ended A.D. 270, and two belonging to the Tetrici, A.D. 267–273, since they would remain in circulation for some time after they were struck. A bronze pin, in the possession of Mr. Jackson, from Dowker-bottom, is remarkable for the head being plated with silver.

The fragment of flattened antler from this cave, referred by Mr. Denny to the elk, most probably belongs to the crown of an old antler of the stag, and the remains of the "Canis primævus" of that author cannot be distinguished from those of a large dog. The bones of the wolf, and an enormous stag in the Museum of the Philosophical Society at Leeds, are probably much older than the Brit-Welsh stratum.

These Caves used as Places of Refuge.

The presence of these works of art, in association with the remains of the domestic animals used for food, is only to be satisfactorily accounted for in the way proposed by Mr. Dixon. Men accustomed to luxury and refinement were compelled, by the pressure of some great calamity, to flee for refuge, and to lead a half-savage life in these inclement caves, with whatever they could

[1] Proc. Geol. and Polytechnic Soc. of West Riding of Yorkshire, 1859, p. 45 *et seq.*

[2] Denny and Farrer, op. cit. 1864–5, 414 *et seq.*; Farrer, Proc. Soc. Antiq. vol. iv.

transport thither of their property. They were also accompanied by their families, for the number of personal ornaments and the spindle-whorls imply the presence of the female sex. We may also infer that they were cut off from the civilization to which they had been accustomed, since they were compelled to extemporize spindle-whorls out of the pieces of the vessels that they brought with them, instead of using those which had been manufactured for the purpose.

The evidence of History as to the Date.

We have already seen from the examination of the coins, that the Victoria cave was occupied during or after the first half of the fifth century, and from the works of art that it may have been, and probably was, occupied at a later time. To fix the latest possible limit to the occupation of the group of caves to which it belongs, we must appeal to contemporary history.

During the first four centuries of Roman dominion in Britain, the spread of the manners and arts of the great mistress of the world followed close upon her success in arms; and the policy of one of the greatest of her generals, Agricola, bore fruit in the adoption of her civilization by the British provincials. The population clustered round the Roman stations, and cities sprang up, such as Chester, Bath, York, and Lincoln, between which a ready communication was maintained by the roads that still remain as monuments of engineering skill, and which, in many cases, have been used uninterruptedly from that time to the present day. Agriculture was carried on to such an extent, that Britain became one of the principal corn-producing regions of the Roman Empire; and a commerce with foreign countries was carried on from the ports on the

banks of the Thames and the Severn (Gildas, i.). The mineral sources were also fully explored ; tin was sought in the mines of Cornwall, lead in those of Derbyshire and Somersetshire, and iron in the forest of Dean, Sussex, and Northumberland. Nor was this material prosperity unaccompanied by the signs of luxury and culture. Numerous villas were dotted throughout the province, resembling in size and plan the quadrangle of a mediæval college at Oxford or Cambridge, and even in ruins astonishing us by their magnitude and the beauty of their tessellated pavements. York was the capital of the province and the centre of government, and consequently Yorkshire must have been, if anything, more completely penetrated with the Roman arts and civilization than any other part of Britain. The relation of the Roman conquerors to the conquered Celtic inhabitants was somewhat analogous to that which now exists between the English and the subject nations in India. Latin was the language spoken by the higher classes in the cities, of the army, and probably of the courts of law ; while in the country the Celtic tongue held its ground, and still survives in the language of Wales. Christianity was probably professed in this country about the time of Constantine, and became the dominant religion by the middle of the fifth century, if not before.

Underneath all the outward signs of prosperity during the Roman rule in Britain, there were causes at work which ensured the ruin of the province. The policy of centralization, and the very perfection of the machinery for government on autocratic principles, which brought about the destruction of the Roman Empire, as in our own days they have nearly ruined France, bore fruit in Britain in the helpless apathy of the provincials when

the machinery was broken up. It is therefore no wonder that when the Roman garrison was finally withdrawn from this country, in the year 409, the provincials were left an easy prey to their enemies. Nor need we wonder that they set up isolated centres of government, which we may term communes, in the year 410, in which each city stood out for itself, instead of combining together for the common weal. From this time forward the inhabitants of the Roman province of Britain, severed from the Roman Empire, became a prey to the many tyrants who sprang up, and the anarchy followed so pathetically described by Gildas. It was at this time that the coinage became debased, and Roman coins afforded the patterns for the small bronze minimi of the Settle cave,[1] which are so abundant among the ruins of Roman cities in this country, such as St. Alban's.

The invaders of Britain must now be considered. The Picts and Scots had secured a rude liberty under the protection of their mountains and morasses, rather than by their success in arms against the Roman legions, and their raids into the Roman province had been curbed by the walls and lines of forts, extending, the one from the Firth of Forth to the Firth of Clyde, the other from the Solway Firth to the Tyne. In spite of these, however, from time to time, in the fourth century, they carried desolation into Northumberland and Yorkshire, even if they did not penetrate farther into the south. And on the withdrawal of the Roman legions, at the beginning of the fifth century, their raids were organized on a much larger scale. In the pages of Gildas we have a melancholy picture of their results. In the letter written to

[1] The authorities for this paragraph are Gildas, Nennius, and others, printed in "Monumenta Historica Britannica," folio, Rolls Publication.

Ætius, the Roman commander in Gaul, in 446, the Britains are described as sheep, and the Picts and Scots as wolves. "The barbarians drive us back to the sea; the sea drives us back again to perish at the hands of the barbarians," are the words put into the mouth of the embassy.[1] One plea for aid, which they advanced, is especially interesting, because it shows incidentally that the Roman civilization did not disappear with the withdrawal of the legions—the plea that unless they were succoured the name of Rome would be dishonoured. Nerved by despair, the British in the following year take up arms, and, according to Gildas, leave their houses and lands, and taking shelter in mountains and forests, and in caves,[2] succeed in driving back their Pictish and Scottish enemies.

It is very significant that *caves* should be mentioned in this account; for the region of Craven is one of the very few in the country in which they are sufficiently abundant to allow of their being used as places of shelter on a scale sufficiently large to be recorded in history; and when we consider that one of the natural highways from Scotland into central England lies through that district, it seems to me extremely probable that the group of caves of which Victoria is one is that referred to. On this point it is worthy of record, that in the year 1745, when the younger Pretender was at Shap, and it was doubtful whether he would take the route through Ribblesdale or by way of Preston, the eldest

[1] "Repellunt nos Barbari ad mare, repellit nos mare ad Barbaros; inter hæc oriuntur duo genera funerum; aut jugulamur aut mergimur." GILDAS, xvii.

[2] "Britones de ipsis montibus, speluncis ac saltibus dumis consertis continue rebellabant." GILDAS, xvii. Bæda, *Hist. Eccles.* lib. i. cxiv.

son of one of the landowners near Settle, was hidden, along with the family plate, in a Cave close to the Victoria, in the belief that the Highlanders were in the habit of eating children as well as of laying hands on the precious metals. The historical notice tallies exactly with the geographical position, and is not inconsistent with the evidence offered by the coins and other remains. The date, therefore, of the occupation may probably be assigned as about the middle of the fifth century.

This, however, is not the latest date that can be assigned. In the year 449, the three ships which contained Hengist and his warriors, landed at Ebbsfleet, in Thanet, and the first English colony was founded among a people who were known to the strangers as "Brit-Welsh."[1] From that time a steady immigration of Angle, Jute, Saxon, and Frisian set in towards the eastern coast of Britain, as far north as the Firth of Forth, until, in the first half of the sixth century, the whole of the eastern part of our island was taken possession of by various tribes,[2] whose names, for the most part, still survive in the names of our counties. The principal rivers also afforded them a free passage into the heart of the country, and the kingdom of Mercia gradually expanded until it embraced, not only the basin of the Trent, but reached as far as the line of the Severn. The river Humber afforded a base of operations for the Anglian freebooters, who founded the kingdom of Deira or modern Yorkshire; while the camp of Bamborough

[1] Anglo-Saxon Chronicle, *passim*.

[2] Anglo-Saxon Chronicle, A.D. 449. "From Anglia, which has ever since remained waste between the Jutes and Saxons, came the men of East Anglia, Middle Anglia, Mercia, and all North-humbria." The MS. A, from which this was taken, ends in A.D. 975. The passage was taken from Baeda who lived in the 8th century.

was the centre from which Ida, who landed with fifty ships in the year 547, conquered Bernicia, or the region extending from the river Tees to Edinburgh. The tide of English colonization rolled steadily westward, until, at the close of the sixth century, the hilly and impassable districts culminating in the Pennine Chain, and extending southwards from Cumberland and Westmoreland, through Yorkshire and Derbyshire, formed the barrier between the Brit-Welsh kingdoms of Elmet and Strathclyde on the east, and the English on the west. To the south of this the Brit-Welsh dominion was bounded by the river Severn, and included Chester and the whole of the basin of the Dee; while Somerset, Devon, and Cornwall, and the district round Bradford and Malmesbury formed the kingdom of West Wales.[1]

The long war by which the borders of England were gradually pushed to the west, at the expense of the Brit-Welsh, was one of the most fearful of which we have any record. The English invaders came over, with their wives and children and household stuff, in such force that the country which they left behind was left desolate for several centuries. Worshippers of Thor and Odin, and living a free life, equally divided between farming, hunting, and war, they were mortal foes to Christianity and to Roman civilization. They destroyed the Brit-Welsh cities with fire and sword; and the ashes of the Roman villas, which are to be found in nearly every part of the Roman province of Britain, testify to the keenness of their hate to everything which was at once Christian, Roman, and Celtic. Gildas forcibly describes the destruction which they wrought among his countrymen, by the metaphor that "the flame kindled

[1] See E. A Freeman, "Norman Conquest," vol. i.

in the east, raged over nearly all the land, until it flared red over the western ocean."[1] In the conquered districts the Brit-Welsh were either exterminated or enslaved, and their civilization was wholly replaced by the rude culture of the English.

It follows, from the nature of this conquest, that any group of remains, such as those in the caves under consideration, must be assigned to the time before the English had possession of the district, and we must therefore see what historical proof is to be found on the point.

At the close of the sixth century the Brit-Welsh kingdom of Elmet (in the basin of the river Aire)—a name which still survives in Barwick-in-Elmet, a little village about seven miles to the north-east of Leeds—extended over the country round Leeds and Bradford, passing westwards towards, if not into, Lancashire, and northwards probably so as to embrace Ribblesdale, and forming a barrier to the westward advance of the English possessors of eastern Yorkshire. Its downfall will give us the latest possible limit which we are seeking for the Brit-Welsh occupation of the Victoria Cave. The two kingdoms of Deira and Bernicia had united to form the powerful state of Northumbria, at the beginning of the seventh century, under Æthelfrith, who carried on the war against the Brit-Welsh with greater vigour than his predecessors. In 607[2] he marched along the line of the Trent, through Staffordshire, avoiding thereby the difficult and easily-defended hilly country of Derbyshire and

[1] "Confovebatur . . . de mari usque ad mare ignis orientalis sacrilegorum manu exaggeratus, et finitimas quasque civitates populans, qui non quievit accensus donec cunctam pene exurens insulæ superficiem, rubra occidentalem trucique oceanum linguâ delamberet."—xxiv.

[2] Anglo-Saxon Chronicle.

East Lancashire, to the battle near Chester, famous for the destruction of the power of Strathclyde, and the death of the monks of Bangor, who fought against him with their prayers. By this decisive blow, the English first set foot on the coast of the Irish Channel, and Strathclyde and Elmet, on the one hand, were cut asunder from Wales. On the other Chester was so thoroughly destroyed that it remained in ruins for nearly three centuries, to be rebuilt by Æthelflæd, "the Lady of the Mercians," in 907, and the plains of Lancashire lay open to the invader.[1] This western advance of the Northumbrians was completed by the conquest of Elmet, in 616, by Eadwine, and the whole district from Edinburgh, as far south as the Humber, and as far west as Chester, became subject to his rule.[2] The latest possible date, therefore, that can be assigned for the occupation of these caves by the Brit-Welsh is determined by that event. It cannot be later than the first quarter of the seventh century, or the time when what remained of Roman art and civilization in that district was swept away by the ancestors of the present dalesmen. The relics in the caves must have been accumulated in the two centuries which elapsed between the recall of the legions in the days of Honorius and the English conquest. They are traces of the anarchy which existed in those times, and they tell a tale of woe, wrought on the Brit-Welsh, by Pict, Scot, or Englishman, as eloquently as the lament of Gildas, or the mournful verses of Talliesin.

[1] On the date of the conquest of Lancashire see "Manchester Phil. and Lit. Soc. Proc." 1873, p. 25. In working out this somewhat difficult question, I am indebted to the Rev. J. R. Green for most valuable aid.

[2] Gildas, Nennius, the Annales Cambriæ, Bæda, and the Anglo-Saxon Chronicle are the authorities for these statements.

They complete the picture of the desolation of those times revealed by the ashes of the villas and cities which were burned by the invaders.

We have now examined the evidence as to date offered by the contents of these caves, and we have seen that it agrees with the contemporary history. It may therefore be concluded that it lies in the fifth and sixth centuries, possibly the first quarter of the seventh.

The Neolithic Stratum.

This occupation of the Victoria Cave by the Brit-Welsh is a mere episode in its history. It was inhabited by man in the neolithic age, at a time so remote that the interval between it and the historical period can only be measured by the rude method by which geologists estimate the relative age of the rocks. At the entrance the dark Romano-Celtic or Brit-Welsh stratum (Fig. 20, No. 4 ; Fig. 21, No. 4) lay buried, as we have seen, under an accumulation of angular fragments of stone which had fallen from the cliff. It rested on a similar accumulation (Fig. 20, No. 3 ; Fig. 21, No. 3) which was no less than six feet thick, and at the bottom of this, at the point where it was based on a stiff grey clay, a bone harpoon (Fig. 26) was discovered, as well as charcoal ; a bone bead (Fig. 27), three rude flint flakes, and the broken bones of the brown bear, stag, horse, and Celtic short-horn (*Bos longifrons*). The harpoon is a little more than three inches long, with the head armed with two barbs on each side, and the base presenting a mode of securing attachment to the handle which has not before been discovered in Britain. Instead of a mere projection to catch the ligatures by which it was bound to the

shaft, there is a well-cut barb on either side, pointing in a contrary direction to those which form the head. Ample use for such an instrument would be found in Malham tarn, some three miles off, and very probably also in that which formerly existed close by at Attermire, but which has been choked up by peat, and is now turned into grass-land by drainage. The remains of the brown bear consist of numerous hollow bones and teeth, and the shaft of a femur with its articular ends broken off, has been polished by friction against some soft substance, so that its surface has a lustre like that of glass.

FIG. 26.—Bone Harpoon (natural size).

The question naturally arises, who were the ancient inhabitants of the cave whose rude implements occur in this lower stratum? From the few remains which we discovered, they were hunters and fishermen, and the possessors of domestic oxen, and possibly horses, and in a much lower state of civilization than the Brit-Welsh inhabitants who succeeded them in the cave after a long interval. There is no proof that they used a coinage, or that they were acquainted with metal. The conclusion that they were neolithic is based on the following evidence:—In 1871 the Exploration Committee examined a small cave about 200 yards off, in King's Scar, and obtained the broken bones of the stag, Celtic short-horn (*Bos longifrons*), goat, and horse, a whet-

stone, and a rudely chipped scraper, to which, subsequently, Mr. John Birkbeck, jun., made the important addition of part of a human thigh-bone. This set of remains, the human thigh-bone excepted, agrees with those in the lower stratum in the Victoria Cave, not merely in the absence of metal, but also in affording signs of a comparatively rude civilization; and we might reasonably expect that the two caves so close to each other, would have been occupied by the same people at approximately the same time. If this be allowed, the thigh-bone may be assigned to one of these earlier inhabitants, the place of habitation being, as is frequently the case, subsequently used for purposes of burial. The thigh-bone itself is characterized by the great development of the muscular ridge known to anatomists as the *linea aspera*, implying the peculiar flatness of shin which is termed by Professor Busk platycnemism. This peculiar form has been met with in the neolithic tumuli of Yorkshire, explored by the Rev. Canon Greenwell, as well as in the human remains which I have discovered in the neolithic caves and chambered tombs of Denbighshire; and since it has not been observed in any human skeletons in this country which are not of that age, it may be fairly taken to prove that a neolithic people formerly lived in Ribblesdale. And further, since the traces of rude culture met with in these two caves are the same as those which characterize neolithic burial and dwelling places throughout Europe, they may be assigned to that remote age. Similar human remains were obtained by Mr. Farrer from the Dowker-bottom Cave, and imply that that cave also was used as a neolithic burial-place.

FIG. 27.—Bone-bead (natural size.)

The identification of this race with the Basque or Iberian stock, from which are descended the small, dark peoples of Derbyshire, Wales, and certain parts of Ireland, must be referred to the chapters on the Neolithic Caves.

FIG. 28.—Stone Adze: *a*, side view; *b*, edge (natural size).

The reputed discovery of an adze (Fig. 28), of a variety of greenstone which Mr. Wyndham identifies with melaphyr, many years ago in the Victoria Cave, may offer additional evidence as to its having been occupied by a neolithic tribe. It was presented to the Museum of the Philosophical Society at Leeds by Mr. Jackson, and figured by Mr. Denny among the remains from the Caves of Craven, and presents characters that have not, to my knowledge, been met with in any other neolithic implement found in Great Britain: one end being roughly chipped for insertion into a socket, while the other is carefully ground into a chisel edge. In these respects, as Mr. O'Callaghan and Mr. Denny have observed, it bears a striking resemblance to the stone adzes used by the South Sea Islanders, and especially in Tahiti;—a resemblance so strong that,

unless it had been traced from the hands of the discoverer into the Museum at Leeds, it would be considered by many archæologists as an implement actually obtained from the South Seas It may have been derived from the lower stratum, which furnished the equally peculiar harpoon, Fig. 26.

The Approximate Date of the Neolithic Occupation.

From the position in which these remains occurred, it is obvious that a neolithic tribe occupied the cave before the accumulation of the angular fragments, six feet in thickness (Fig. 20, No. 3; Fig. 21, No. 3), just as the date of the Brit-Welsh occupation is fixed as being after this, and before the accumulation of the two feet of débris above (No. 5). And in this we have a means of roughly estimating the interval of time between them. It is clear that the accumulation of two feet of angular fragments, torn away by the action of the weather from the cliff, has been formed in about 1,200 years, *i.e.* between the Brit-Welsh occupation and the present time. If it be admitted that equal quantities of the cliff have been weathered away in equal times, it will follow that the thickness of six feet between the Brit-Welsh stratum and that under examination was formed during a time thrice as long, or 3,600 years; and that consequently the date of the earlier occupation of the cave by man is fixed as being about 4,800, or 5,000 years ago. It is perfectly true, that in ancient times the frosts may have been more intense than they are now, and therefore that the rate of weathering may have been faster. To the objection that possibly a large mass of cliff may have tumbled down at one time, and subse-

quently been disintegrated, it may be answered, that at the point at the entrance where the section was taken there was no evidence of any such fall; the angular blocks, both above and below the Brit-Welsh stratum, being as nearly as possible of the same size, and not lying with their faces parallel to each other, as would have been the case had they been disintegrated fallen blocks. Nevertheless this attempt to fix a date cannot lay claim to scientific precision, and in that respect is neither better, nor worse, than any other similar attempt founded on the rate at which a valley is being excavated, or alluvium being deposited, or on the retrocession of a waterfall, such, for example, as Niagara. It is merely valuable as enabling us to form some sort of idea of the high antiquity of the neolithic men who left these remains behind in the cave.

As the trench (see Figs. 20, 21) begun on the outside passed into the entrance of the cave, the accumulation of stones above the neolithic stratum disappeared, and the latter became intermingled with the Brit-Welsh layer above, so that it would have been impossible to distinguish the one from the other had not the talus marked the interval in the plateau outside. The talus also above the Brit-Welsh stratum ceased at the entrance, although here and there large blocks of stone, fallen from time to time from the roof, rested on its upper surface.

The Grey Clays.

Immediately below the neolithic stratum, a deposit of stiff grey clay of unknown depth occupies both the entrance and the inside of the cave (Figs. 20, 21), containing fragments of limestone and large angular blocks

which had fallen from the roof. A shaft sunk to a depth of twenty-five feet near the entrance failed to arrive at the bottom, but presented the following section in descending order: stiff grey clay with layer of stalagmite six feet thick; a finely laminated calcareous clay twelve feet thick; and below, a similar bed of clay to that on the surface. In a second shaft sunk to the depth of twelve feet farther within the cave, the base of the grey clay was not reached.[1]

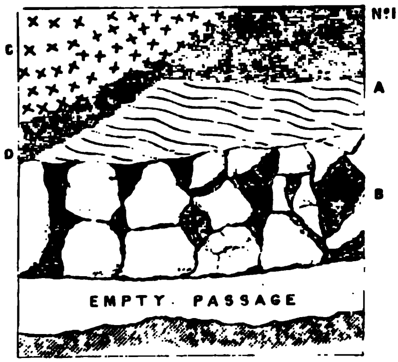


FIG. 29. –Section below Grey Clay at entrance.

A third shaft, at the entrance, however, penetrated the clay, No. 1 of Figs. 20, 21, 29, at a depth of about five feet, and revealed the existence below of a reddish-grey loamy cave-earth (Fig. 29, A), containing bones and teeth of the same animals as those from the caverns

[1] The section of the Victoria Cave published by Mr. Tiddeman in the Geological Magazine expresses the relation of the clay with boulders to the cave-earth with greater clearness than I could observe on the ground. The laminated clay is not yet proved to occupy such a large area in the cave, or to be so regularly deposited, or so clearly defined. It occurs at *various* levels in the mass of the grey clay in the section (to be seen on May 21, 1873), above and below the cave-earth.—"The Older Deposits in the Victoria Cave," Geol. Mag. x. p. 11.

of Kent's Hole, Wookey Hole, and others, which belonged to a group that invaded Europe before the glacial period, and that inhabited the region north of the Alps and the Pyrenees in pre- and post-glacial times.[1]

We subsequently discovered the cave-earth to be from three to four feet thick, and that it rested on an accumulation (Fig. 29, B) of large blocks of limestone, the interstices between which were filled with clay, sometimes laminated and at others homogeneous, as well as with coarse sand. Below this we broke into an empty passage, one side of which was formed by the solid rock, and the other of blocks of stone imbedded in the clay.

As we opened out a horizontal passage towards the cave-earth, A, from the outside, the talus (Fig. 29, C) of angular débris was cut through first, which gradually became more and more clayey in its lower portions: at one point, D, there were several glaciated blocks, some imbedded in clay and others perfectly free. It rested obliquely on the edges of the cave-earth, and passed gradually at the entrance into the clay occupying the interior of the cave.

The Pleistocene Occupation by Hyænas.

The remains of the spelæan variety of the spotted hyæna were very abundant in the cave-earth, consisting of fragments of skulls, jaws, and bones, and especially of coprolites, which formed irregular floors, accumulated during successive occupations of the cave by that animal. All the bones were gnawed and scored by

[1] See Essays by the writer in "Pop. Sci. Rev." Oct. 1871: "On the relation of the Pleistocene Mammalia to the Glacial period." "On the Classification of the Pleistocene Strata of Europe by means of the Mammalia;" Quart. Geol. Journ. June 1872.

teeth, the lower jaws were without the angle and coronoid process (see Fig. 92), and the hollow bones which contain marrow were broken, while those which were solid and marrowless were for the most part perfect: and this held good, not merely of the remains of the hyæna, but of those of all the animals which constituted their prey. The bones,

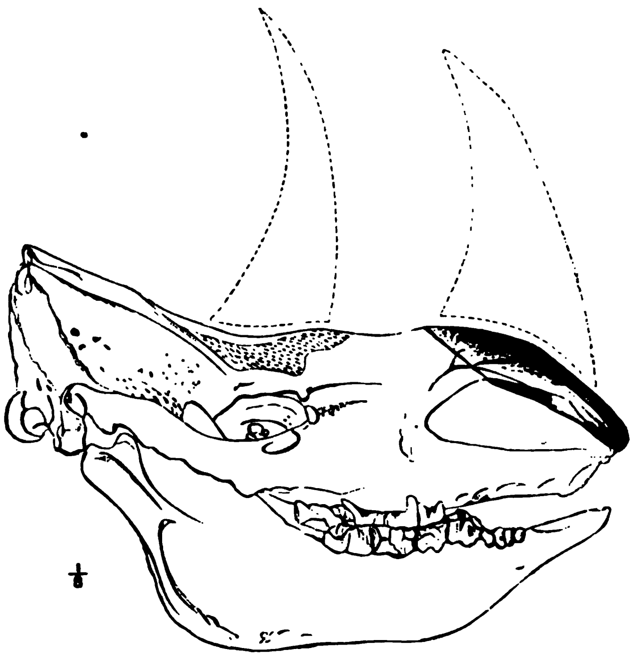


FIG. 30.—Skull of Woolly Rhinoceros, showing the part which is not eaten by the hyænas.

for example, of the woolly rhinoceros are represented merely by the hard distal portion of the shaft of the humerus, and of the solid bones of the ulna and radius, while the only portions of skull are the solid pedestal offered by the nasal bones on which the front horn was supported, and a few smaller fragments. The pedestal in question is depicted by the dark shaded portion of

Fig. 30, the outline of the skull and lower jaw being taken from one of Professor Brandt's plates of the Woolly Rhinoceros found in Siberia.[1] The teeth which imply the presence of the mammoth (milk molars 3 and 4) were those of a young individual, as is very generally the case in caves which have been occupied by hyænas. The young would naturally be more exposed to the attack of those cowardly beasts of prey than the adult, armed with its long curved tusks, and defended, not merely by its thick skin, but also by the covering of wool and long hair which is peculiar to the species. Besides these animals, the reindeer, red-deer, bison, horse, the brown, grizzly, and great cave bears, were preyed upon by the hyænas and dragged into the cave. All these species were discovered within an area of a few square yards of cave-earth, which passes into the interior of the cave under the grey clay. They belong to that well-defined group known as pleistocene, quaternary, or post-pleiocene, which was proved to have inhabited Yorkshire[2] in ancient times from Dr. Buckland's discoveries in Kirkdale, and Mr. Denny's examination of the river-deposit at Leeds, in which the remains of the hippopotamus were obtained.

The last and most important addition to this fauna is that of man, a fragment of fibula in the same mineral condition as the rest of the pleistocene bones, having been identified by Professor Busk with an unusually massive recent human fibula. Although the fragment is very small, its comparison with the abnormal specimen in Professor Busk's possession removes all doubt

[1] Mém. de l'Acad. Imp. des Sciences de St. Pétersbourg, 6e Sér. tome v. 1849, Pl. xiii. Fig. 1.

[2] See my "Pleistocene Mammals of Yorkshire," Geol. and Polytechnic Soc. of West Riding of Yorks. Leeds, Aug. 6th, 1866.

from my mind, as to its having belonged to a man, who was contemporary with the cave-hyæna and the other pleistocene animals found in the cave.

The probable Pre-glacial Age of the Pleistocene Stratum.

Is this occupation of the Victoria Cave by the pleistocene mammalia pre-glacial or post-glacial?—before, or after, the great lowering of the temperature in northern Europe? This difficult question can only be answered by an appeal to the physical history of the clay and cave-loam, and to the evidence as to glacial action in the district, and to the distribution of the mammalia in Great Britain during the pleistocene period. Glaciers have left their marks in nearly every part of Lancashire and Yorkshire, and especially in the neighbourhood of the Victoria Cave. The hill-sides around are studded with large ice-borne Silurian rocks; boulder-clay occupies nearly every hollow on the elevated plateaux; and moraines are to be observed in nearly every valley. At the entrance of the cave itself, ice-scratched Silurian grit-stones are imbedded in the clay, which abuts directly on the cave-loam, and passes insensibly into the clay, with angular blocks of limestone within the cave. They may possibly be the constituents of a lateral moraine *in situ*, as Mr. Tiddeman suggests, or they may merely be derived from the waste of boulder-clay which has dropped from a higher level.

The latter view seems to me to be most likely to be true, because some of the boulders have been deprived of the clay in which they were imbedded, and are piled on each other with empty space between them, the clay

being carried down to a lower level and re-deposited. Their position, however, on the edges of the cave-earth implies, in any case, that they had been dropped after its accumulation.

There is another point to be considered in the physical evidence. The deposits above the cave-earth, occupying the interior and entrance of the cave, have been introduced by the rains, either through the entrance, or through the crevices which penetrate the roof, and consist of a finer detritus washed out of the boulder-clay on the surface at a higher level. The cave-earth, however, although it has been introduced in the same way, cannot be accounted for on the supposition that it was derived from the boulder-clay, with which it contrasts in the fact that it is a loam, of a reddish grey colour, containing a large percentage of carbonate and phosphate of lime.

Similar deposits, characterized by their red colour, are to be found in nearly all the caves of the south of England, in France, and southern Europe, not complicated, as here, by the glacial phenomena of the district. Had the layer been formed in the Victoria Cave, from the destruction of the boulder-clay, it would have been identical in composition with the deposits above.

The laminated portions of the grey clay are considered by Mr. Tiddeman to have been formed by the flow of water through the entrance, derived from the daily melting of the glacier which occupied the valley in ancient times, and he compares it with a similar lamination in the boulder-clay at Ingleton, which has been described by Mr. Binney in the neighbourhood of Clifton, near Manchester, under the expressive name of "book-leaves." Since, however, similar accumulations

are being formed at the present time at the bottom of pools in many caves, as, for example, in that of Ingleborough, they cannot be taken to imply a glacial origin. They are not found merely in one spot in the Victoria Cave, but are scattered, more or less, through the general mass of the clay, and occur abundantly even below the cave-earth, having been deposited in the interstices between the large blocks of limestone. In these positions they are of uncertain age, and there is no reason why some of the hollows which we discovered below the cave-earth (Fig. 29, B) should not be filled with them at the present time by the heavy rains. They dip at all angles, and are conformable to the surfaces on which they have been dropped.

The most important argument in favour of the pre-glacial age of the mammaliferous cave-earth is afforded by the range of the animals in Great Britain during the time that certain areas were occupied by glaciers. In a paper read before the Geological Society in 1869, I showed that those areas in Great Britain in which the marks of glaciers were the freshest and most abundant coincided with those which were barren of the remains of the pleistocene mammalia, and I therefore inferred that this was due to the fact, that the areas in question were covered by ice at the time that pleistocene animals were so numerous in the caves, and river-deposits of southern and eastern England, and on the continent. In a map published in 1871, Cumberland, Westmoreland, Lancashire, and the greater portion of Yorkshire are represented as being one of these barren areas, in which no pleistocene mammalia have been observed. It is obvious that the hyænas, bears, mammoths, and other creatures found in the pleistocene

stratum, could not have occupied the district when it was covered by ice; and had they lived soon after the retreat of the ice-sheet, their remains would occur in the river-gravels, from which they are absent throughout a large area to the north of a line drawn between Chester and York, whilst they occur abundantly in the glacial river deposits south of that line. On the other hand, they belong to a fauna, that overran Europe, and must have occupied this very region before the glacial period, since their remains have been found in pre-glacial strata to the north in Scotland, to the south at Selsea, and to the east in Norfolk and Suffolk. It may, therefore, reasonably be concluded that they occupied the cave in pre-glacial times, and that the stratum in which their remains lie buried, was protected from the grinding of the ice-sheet, which destroyed nearly all the surface accumulations in the river-valleys, by the walls and roof of rock, which has since, to a great extent, been weathered away.[1] This view is also held by Mr. Tiddeman.

The exploration of the Victoria Cave, which has hitherto yielded such interesting evidence of three distinct occupations—first by hyænas, then by neolithic men, and lastly by the Brit-Welsh, is by no means complete. The cave itself is of unknown depth and extent, and the mere removal of so much earth and clay as it is at present known to contain will be a labour of years. The results of the exploration, up to the present time, are of almost equal value to the archæologist, to the historian, and the geologist, and prove how close is the bond of union between three branches of human thought which at first sight appear

[1] See Brit. Ass. Reports, Bradford, 1873.

remote from each other. The discussion of the problems connected with the neolithic and pleistocene strata must be referred to the fifth and following chapters.

The Kirkhead Cave.

Other caves in this country, besides the group under consideration in Yorkshire, have been occupied by the Brit-Welsh. That known as the Kirkhead Cave, on the eastern shore of the Promontory of Cartmell, on the northern shore of Morecambe Bay, explored by Mr. J. P. Morris,[1] and a Committee of the Anthropological Society in 1864–5, contained remains of the same type as those of the Brit-Welsh stratum in the Victoria Cave. In the débris which formed the floor and extended to an unknown depth below, a coin of Domitian, "a trefoil-shaped Roman fibula," a pin, ornamented with green enamel, and a bronze ring were discovered in association with broken remains of domestic animals—*Bos longifrons*, pig and goat, dog and horse, as well as stag, roe, wild goose, and many human bones. A bronze celt and a spear-head were also found, at a depth respectively of five and six feet, and a flint flake at a depth of seven feet; and fragments of pottery, a bead of amber, cut bones, the perforated head of the femur, and other articles. From this group of remains it may be inferred that the cave was occupied by the Brit-Welsh, and before them by the users of bronze, and possibly by a neolithic people, and that it had at some time or another been used as a place of burial. Just inside the entrance, which overlooked the sea at a height of 45 feet, a semi-circular breastwork of large

[1] Mem. Anthrop. Soc. vol. ii. p. 358.

stones rendered the cave habitable, and capable of easy defence.

Mr. Morris's view that the discovery of a bronze celt, flint flakes, and coins in this cave proves that all three were in use at the same time, and by the same people, is not borne out by the published account of the excavation. There is no proof that the deposit had not been disturbed, or that the articles were not dropped at different times. And in support of this conclusion, it may be advanced, that there is no case on record of the discovery of bronze celts or swords along with any Roman coins under conditions which would prove that they were in use at the same time. Had such been the case the ruins of the many Roman villas and cities, destroyed by the English, would have furnished some examples. At Silchester, even such a rare article as a Roman eagle has been met with. There is every reason to believe with Sir John Lubbock, Mr. Evans, and other eminent archæologists, that the use of bronze for weapons had been superseded by that of iron before the dawn of history in this country. It is otherwise with the flint flakes; since my discovery of several inside a Roman coffin at Hardham, near Pulborough, in Sussex, in a cemetery that belongs to the later portion of the Roman dominion in Britain, proves that they were used for some purpose at that time.[1]

Poole's Cave, near Buxton.

In the collection of articles obtained from Poole's Cave, in Buxton, in Derbyshire, I identified, in 1871, in company with Mr. Pennington, bronze Roman coins, minimi, Samian and other ware, and large quantities of

[1] Sussex Archæol. Coll., 1863.

broken bones of the same animals as those from the Victoria Cave. A bronze harp-shaped fibula of the type of Fig. 5 of the coloured Plate is inlaid with silver, and is so perfect that it might still be used.

Thor's Cave, near Ashbourne.

A cave also, in Staffordshire, four miles from Ilam, explored by the Midland Scientific Association in 1864,[1] under the supervision of Mr. Carrington, has furnished articles of the same kind as those of Yorkshire. It is known as Thor's cave, and penetrates the lofty cliff of limestone, on the south side of the river Manifold, at a height of about 254 feet from the bottom of the valley, and about 900 feet above the sea, running horizontally inwards, and being divided inside by a row of buttressed columns into two noble gothic aisles. Its bottom was occupied by clay, in which, near the entrance, there were thick layers of charcoal at depths of two, three, and four feet below the surface, mingled with broken bones and pottery, that indicated the spots where fires had been kindled. The articles discovered were as follows:—

"*Bronze.*—Armlet, two fibulæ of harp pattern (see coloured Plate, Fig. 5), two plain breast-pins and rings, a curious wheel-shaped instrument.

"*Iron.*—Large triangular fork, arrow-heads, lance-heads, several knives and a chopper, of singular shapes, reaping hook (?), adze, pins, two girdle hooks (?), &c.

"*Bone.*—Seven snags of deer's horns, variously cut and perforated, several others not perforated, curious bone comb ornamented with circles, flat bone perforated with

[1] Trans. Midland Sci. Ass., Sess. 1864–5, pp. 1—6, 19, 29, Plates 1—15, "Report on the Exploration of Thor's Cave," by E. Brown, Esq.

four holes, two leg-bones carved at the ends, pin, a large quantity of bones of animals that had been consumed for food.

"*Stone.*—Greenstone pounder, fragments of querns, perforated disk, &c.

"*Pottery.*—A large collection of fragments of various periods, among the rest several pieces of true Samian ware."

Mr. Edwin Brown, from whose report this list is taken, concludes that Thor's cave was occupied during "the late Celtic and Romano-Celtic periods." The harp-fibulæ are of a pattern identical with several of those discovered in the Victoria Cave, and the holes at their upper ends were probably intended for the reception of enamel. The bronze instrument, consisting of a disk cut out into a flamboyant pattern like that of the round brooch from the Victoria Cave (Fig. 25), and joined to a central stem ornamented with waved lines, was intended for suspension; possibly, as Mr. Carrington suggests, it may have been used for spinning. It is a remarkably fine example of Brit-Welsh or late Celtic art. The bone comb is of the same type as those from the Brit-Welsh caves of Yorkshire. It is evident, from Mr. Brown's account, that there were distinct layers of occupation; but, unfortunately, the articles found in each were not separated from the rest. One armlet (Fig. 31), composed of a thin plate of bronze, and ornamented with a dotted-line pattern, is of the peculiar type which is characteristic of the bronze age.

The cave had also been used as a place of sepulture, for near "the pulpit rock," and at a depth of five feet from the surface, a skeleton rested in the sitting posture which is so characteristic of neolithic interments in

Europe. It had also been entered by man even before any of these accumulations. "In the south recess, behind and below any traces of man's occupation, the diggers came upon a kind of flooring of tabular masses

FIG. 31.—Bronze Bracelet from Thor's Cave.

of breccia stretching almost across the cave, and on one side attached firmly to the wall," beneath which rested, in the undisturbed clay, a deer's horn, rudely sawn across and perforated by two holes.

Thor's Cave, therefore, like the Victoria, has been occupied by man in the Brit-Welsh stage of the historic period, as well as in the bronze, and possibly in the neolithic ages.

Historic Value of Brit-Welsh Group of Caves.

The discovery that caves were used as habitations by men accustomed to the elegance of civilized life, not merely in Yorkshire, but in districts so far removed from each other as Staffordshire and the extreme north of Lancashire, during the fifth and sixth centuries, implies the pressure of a far-reaching calamity by which they were driven from their homes. It completes and rounds off the story of the social condition of the country during these troubled times, which is revealed in the sacked

and burned Brit-Welsh cities and villas, as well as in the scanty records of the English invasion.

Subsequent investigation will probably show that caves were occupied at this time in every part of the country which was conquered by the English. In the upper stratum of Kent's Hole, for example, near Torquay, similar articles, with the exception of the enamels, have been discovered. There, however, the occupation may have been considerably later than in the caves of Yorkshire, because the Roman civilization was not supplanted in Devonshire by the English until the beginning of the ninth century. The river Tamar then marked the frontier between the English, and the Brit-Welsh of the promontory of Cornwall, which represented the dominion of West Wales in the days of Ecgberht.[1]

In the numerous caves of Wales, on the other hand, which I have explored, there is no trace of inhabitants of the fifth and sixth centuries, a circumstance that is easily accounted for by the fact that Wales was not invaded at that time by the English. There would therefore be no reason for the civilized Brit-Welsh to fly to caves for refuge.

Principal Animals and Articles in Brit-Welsh Caves.

The following are the more important animals and articles found in the group of caves under consideration. The species are identical with those which I have tabulated from refuse-heaps of Roman age.[2]

[1] See E. A. Freeman, "Norman Conquest," vol. i. p. 43.

[2] Preliminary Treatise on the Relation of the Pleistocene Mammalia to those now living in Europe. Palæont. Soc. 1874, chap. ii.

List of Principal Animals and Objects found in Brit-Welsh Strata in Caves.

ANIMALS.	Victoria	Kelko.	Dowker Bottom.	Kirk-head.	Poole's Cavern.	Thor's Cave.
DOMESTIC.						
Canis familiaris—Dog	×	×	×	×	×	?
Sus scrofa—Pig	×	×	×	×	×	?
Equus caballus—Horse	×	×	×	×	×	?
Bos longifrons—Celtic Short-horn	×	×	×	×	×	?
Capra hircus—Goat	×	×	×	×	×	?
WILD.						
Canis vulpes—Fox	×	...	×	×	×	?
Meles taxus—Badger	×	...	×	...	...	×
Cervus elaphus—Stag	×	...	×	×	×	?
Cervus capreolus—Roe	×	...	×	×	...	?
Roman coins or imitations	×	×	×	×	×	×
Enamelled ornaments in bronze	×	×	×	×	...	...
Bronze ornaments inlaid with silver	×	×	×	...	×	...
Iron articles	×	×	×	...	×	×
Samian ware	×	...	×	...	×	×
Black ware	×	×	×	...	×	×
Bone-spoon fibulæ (Fig. 22)	×	×	×	...	...	...
Bone combs	×	×	×	...	...	×

All the less important animals and articles are omitted from this list. It will be observed that the brown bear, the wolf, and the fallow-deer are absent. The brown bear was probably at this time very rare in Britain, since its remains have been met with in but two out of the many Roman refuse-heaps in the country, at London and Colchester. The well-known lines of Martial, however, imply that it was imported from Britain to Rome at this time—

> "Nuda Caledonio sic pectora præbuit urso,
> Haud falsa pendens in cruce Laureolus."

It probably became extinct about the ninth or tenth century. The wolf obviously would not be likely to be used for food, although it probably was abundant in the district. The fallow-deer also had not penetrated into

the hilly districts, although it had become naturalized in this country by the Romans, so as to have been frequently used as an article of food before the English invasion. I have seen its characteristic antlers in refuse-heaps, both in London and Colchester, which have furnished Roman coins and pottery.

The beaver was probably very rare in the fifth and sixth centuries, and has been met with in no cave-deposit, either historic or prehistoric, in this country. It was, however, known to the Anglian conquerors of Yorkshire (Northumbria), who called Beverley (lea, leag-) after its name.

The Use of Horseflesh.

The broken bones of the horse, in all the caves above mentioned, leave no room to doubt that horseflesh was a common article of food at that time. It was so, indeed, throughout Roman Britain, and after the English invasion was used as late as the Council of Celchyth,[1] in the year 787. It was forbidden by the Church because it was eaten by the Scandinavian peoples in honour of Odin. In Norway,[2] Hacon, the foster-son of Æthelstan, was compelled to eat it by the bonders, in 956, and the revolt of the bonders which ended in the bloody battle of Stikklestadt, in which Olaf met his death, in 1030, was caused by his cruelties to the eaters of horseflesh. As Christianity prevailed over the worship of Thor and Odin, it

[1] "Equos etiam plerique in vobis comedunt, quod nullus Christianorum in orientalibus facit." Haddan and Stubbs, "Councils and Ecclesiastical Documents relating to Great Britain and Ireland," vol. ii. p. 459.

[2] Laing, "Norway," p. 316. Mr. Laing justly argues that the habit of eating horseflesh in Norway, where pasturage is scant, must have been acquired in the luxuriant grassy steppes of Central Asia by the ancestors of the Scandinavians.

was banished from the table. The present prejudice against its use is a remarkable instance of the change in taste, which has been brought about by an ecclesiastical rule aimed against a long-forgotten faith. The rule was not, however, always obeyed, for the Monks of St. Gall, in the eleventh century, not only ate horseflesh, but returned thanks for it, in a metrical grace, written by Ekkehard the Younger (died 1036) :—

"Sit feralis equi caro dulcis sub cruce Christi."[1]

The Cave of Longberry Bank.

The cave of Longberry Bank, near Penally, in Pembrokeshire, may also be classed with those which were inhabited in historic times, since it contained red fine-grained pottery of a kind commonly found in the ruins of Roman villas. It was explored by the Rev. H. H. Winwood, in 1866, in whose collection are the remains of the *Bos longifrons*, goat, badger, dog, as well as shells of oyster, large limpets and mussel from the neighbouring shore. Some of the bones are burned. Several human vertebræ and a metacarpal were probably the traces of an interment of unknown date; and the two flint flakes are of uncertain age.

The results obtained by the exploration of the caves described in this chapter are to be taken merely as the first-fruits of a new line of inquiry, which is likely to throw light on many points relating to art, history, and the range of the animals, and not as being perfect or final. On the continent, no historic caves of importance have as yet been explored.

[1] Benedict. ad Mensas Ekkehardi Monachi Sangallensis, Pertz. Mon. Germ., vol. vi. p. 117.

CHAPTER IV.

CAVES USED IN THE AGES OF IRON AND OF BRONZE.

The Difference between Historic and Prehistoric Time.—The Prehistoric Fauna.—The Archæological Classification.—Caves of the Iron Age.—Caves of the Bronze Age in Britain.—The Caves of Césareda in Portugal probably occupied by Cannibals.—The Cave of Reggio in Apulia.

The Difference between Historic and Prehistoric Time.

IT will be necessary before we examine the group of caves used by man in prehistoric times, to point out the important difference in the measurement of time within and beyond the borders of history. When we speak, for example, of the date of the Norman Conquest, we imply that we can ascertain by historical records, not merely that it succeeded the invasion of Britain by the English or Danes, and happened before our own time, but that the interval which separates it from those events can be accurately measured by the unit of years. If, however, we attempt to ascertain the date of any event which happened outside the historical limit, we shall find that it is a question solely of relation. When we speak, for example, of the neolithic age, we merely mean a certain stage of human progress which succeeded the palæo-

lithic, and preceded the bronze age, but we have no proof of the length of the interval dividing it from the one or the other. The historic "when?" implies "how long ago?" the prehistoric "when?" merely implies a definition before and after certain events, without any idea of the measurement of the intervals.

An attempt to ascertain the absolute date of prehistoric events must of necessity fail, since it is based on the improbable assumption that the physical agents have acted uniformly, and that therefore the results may be used as a natural chronometer. The present rate of the accumulation of *débris*, as at the Victoria Cave of the preceding chapter, or of that of silt in the deltas of rivers, such as the Nile, or the Tinière, may convey a rough idea of the high antiquity of prehistoric deposits; but a slight change either of the climate, or of the rainfall, would invalidate the conclusion. When the greater part of Europe lay buried under forest, when Palestine supported a large population, and when glaciers crowned some of the higher mountains of Africa, such as the Atlas, the European and Egyptian climates were probably moister than at the present time, and the rainfall and the floods greater, and consequently the accumulation of sediment quicker than the observed rate under the present conditions. And in the same way all estimates of the lapse of past time, based upon the excavation of a river valley, or the retrocession of a waterfall, such as Niagara, lie open to the same kind of objection. It is not at all reasonable to suppose that the complex conditions which regulate the present rate of erosion, have been the same during the time the work has been done, and it therefore follows that the work done is a measure of the power employed, and not of

the length of time during which it has been in operation. We must, therefore, give up the idea of measuring the past beyond the memory of man, as represented in historical documents, by the historic unit of years. We can merely trace a definite sequence of events, separated one from another by uncertain intervals. And for that series of events which extends from the borders of history back to the remote age where the geologist, descending the stream of time, meets the archæologist, I have adopted the term prehistoric.[1]

The Prehistoric Fauna.

The prehistoric period is characterized by the arrival of the domestic animals in Europe, under the care of man. The dog, swine, horse, horned-sheep, goat, *Bos longifrons*, and the larger ox descended from an ancestor, according to Professor Rutimeyer, of the type of the great Urus, make their appearance together, in association with the remains of man, in the neolithic stage of civilization.[2] Subsequently they spread over the whole of our continent, for the most part under the care of man. The *Bos longifrons*, however, and possibly also the Urus, reverted to feral conditions, just as the horses and oxen, in the Americas and Australia, have done at the present time, and their remains are therefore frequently found in association with animals undoubtedly wild. The domestic horse, the variety of hog descended from the wild boar, and the domestic cattle derived from the Urus, may possibly have passed under the yoke of man,

1 "Pleistocene Mammalia." Palæont. Soc. 1866. Introd. Internat. Congress of Prehistoric Archæology, Paris, and Norwich volumes.

2 These questions are treated in detail in my Preliminary Treatise, "Brit. Pleist. Mammalia." Palæont. Soc. 1874.

in Europe, since their wild stocks were to be found in that area, both in the prehistoric and pleistocene times. This, however, cannot be affirmed of the swine descended from the southern variety of *Sus Indica*, or of the Celtic shorthorn, of the sheep, or goat, since their wild ancestors were not indigenous in Europe. These animals must have been domesticated in some area outside Europe; and since central Asia is the region where the wild stocks still exist, from which all the domestic animals are descended, it is reasonable to suppose that they were domesticated in that region, and thence introduced, by a race of shepherds and herdsmen, into our quarter of the world.

This conclusion is considerably strengthened by the evidence which Professor Heer has advanced, as to the vegetables used by the dwellers on piles in the Swiss lakes, among which some, such as the two kinds of millet, the six-rowed barley (hordeum hexastichon), the Egyptian wheat (triticum turgidum), and a weed (Silene cretica), accidentally brought along with them, are distinctively of southern derivation.

The most important wild animals living in this country during the prehistoric period are the urus, the gigantic skulls of which occur in the peat bogs of England and Scotland, the Irish elk, the moose (*Cervus alces*), and the reindeer. The two last are far more abundant in the north than in the south of Britain; their remains have been discovered in the neighbourhood of London, those of both animals at Walthamstow, and those of the latter at Crossness in Kent, on the banks of the Thames. The remains of the bison have not been recorded from any prehistoric deposit in this country.

The Irish elk is the only animal which has become

extinct; while the moose, or true elk, is the only wild species which has not been proved to have been living in the preceding age. The stag was very abundant.

The prehistoric fauna is distinguished from that of the pleistocene not merely by the appearance of the animals above mentioned, which were hitherto unknown, but by the absence of many species which were living during the latter period. The cave bear, woolly rhinoceros, and mammoth, for example, became extinct, the musk-sheep and lemming were banished from a temperate latitude to take refuge in the regions of the north, while the spotted hyæna, the hippopotamus, and Felis caffer, retired to the warm regions of Africa, where they are still living.

The Archæological Classification.

The prehistoric period has been classified by the archæologists according to the stages of human progress which it presents. At the frontier of history, in each country, we find that the dwellers were acquainted with the use of iron, and had found it to be the most convenient material for the manufacture of cutting weapons and implements. Before this the voice of tradition points out that bronze was the only material used for these purposes, and stone before bronze. These three stages of human culture, or the ages of iron, bronze, and stone, have been fully verified by investigations which have been made in various parts of Europe, into the prehistoric habitations and burial-places of man.

This classification by no means implies an exact chronology, or that any one of these ages, with the exception perhaps of the first, covered the whole of Europe at the same point of time, but that the order in

which they followed each other is the same in each country which has been explored. There is good reason for the belief, that at the time the Egyptian and Assyrian empires were in the height of their glory, Northern Europe was inhabited by rude polished-stone-using races. And it is a well-ascertained fact, that while the inhabitants of Britain and Scandinavia were in their bronze age, the Etruscans and Phœnicians were in their full power in the south. It is obvious again, that, even in the same country, the poorer classes must have been long content to use the ruder and more common materials for their daily needs, while the richer and more powerful used the rarer and more costly. These three ages must therefore necessarily overlap. "Like the three principal colours of the rainbow," writes Mr. Evans,[1] "these three stages of civilization overlap, intermingle, and shade off the one into the other; and yet their succession, as far as Western Europe is concerned, appears to be equally well defined with that of the prismatic colours, though the proportions of the spectrum may vary in different countries." They cannot reasonably be viewed as hard and fast lines of division, mapping off successive quantities of time.

The age of stone is subdivided by Sir John Lubbock into the neolithic periods, or that in which polished stone was the only material used for cutting, and the palæolithic, in which mankind had not learnt to grind and polish his implements. The latter belongs to the pleistocene, or quaternary period, since the palæolithic implements are found in association with the remains of the animals characteristic of that age.

The prehistoric caves, therefore, may be divided into three classes if the archæological method of analysis be

[1] "Ancient Stone Implements of Great Britain," p. 2.

employed: 1, into those containing evidence of the use of iron; 2, those containing proof of the knowledge of bronze; 3, and lastly, those in which traces of polished stone weapons have been discovered unassociated with metals. By the animal remains which they contain they may be distinguished from those of the pleistocene age, both by the absence, as well as the presence of certain species which have been enumerated.

From the archæological point of view, two out of the four ages are still represented. Stone is, at the present time, the only material used in the more remote regions of Australia, although it is fast being replaced by iron, which has superseded bronze, and is spreading rapidly over the whole earth. The group of historic caves described in the preceding chapter may be said to belong to the iron age, that is to say, to that later portion of it in which the events are recorded in history.

The traces of the occupation of caves by man in the iron and bronze ages are so extremely scarce, that it is certain that they were but rarely used as habitations. Man had sufficiently advanced in civilization in those times to construct artificial dwellings and tombs for himself, instead of using the natural shelters which were so very generally occupied in Europe by his ruder neolithic predecessors.

Cave of the Iron Age.

In the course of the systematic exploration of caves in the Mendip Hills, carried on by Messrs. Ayshford Sanford, Parker, and myself, a cave was examined in Burrington Combe, near Wrington, in Somerset, which may be referred to the iron age, and which we named Whitcombe's Hole. It opened upon the side of that

magnificent combe, at a height of about 135 feet from the bottom and fifteen from the top, and ran horizontally inwards, the floor being formed of an accumulation of earth mingled with charcoal, and containing numerous broken bones and teeth. The latter belonged to the wolf, fox, badger, rabbit, hare, stag, goat, and Celtic shorthorn. In the lower portion were the fragments of a rude, unornamented urn of a coarse black ware, with the rim turned at right angles, along with a bent piece of iron, which bears a strong resemblance to those found strengthening the corners of wooden coffins in the Gallo-Roman graves on the banks of the Somme. The fractures of the bones, with one exception, were caused by the hand of man, and not by the teeth of the carnivora. The position renders the cave eminently fitted for concealment, for while commanding an extensive view down the Combe, it is invisible both from above and below, and opening on the face of an almost vertical cliff, it is easily defended. If the urn be sepulchral, the interment must be of a later date than the occupation, because it is made in the *débris* which resulted from the latter.[1]

Caves of the Bronze Age in Britain.

The cave of Heathery Burn,[2] near Stanhope, in Weardale, co. Durham, is the only one in this country that has furnished a large series of articles of the bronze age. It is described by Mr. Elliott as running into the

[1] Somerset Archæol. and Nat. Hist. Soc. 1864. "On the Caverns of Burrington Combe."

[2] Elliott, "Geologist," 1862, p. 34, ditto p. 167. Huxley, ditto, p. 205. Carter Blake, ditto, p. 312. Mackie, "Proceed. Soc. Antiq." 2nd Series, vol. ii. p. 177.

precipitous side of a ravine, at a height of about 10 to 12 feet above the level of the Stanhope Burn, and as being partially traversed by water. Since its discovery in 1861, it has been altogether destroyed by the removal of the stone to be used as a flux in smelting the ore of the Weardale Iron Company, and an admirable section of its contents was therefore visible from time to time. A stratum of sand at the bottom, two feet nine inches thick, deposited by the stream, and containing angular masses of limestone that had dropped from the roof, was covered by a sheet of stalagmite three inches in thickness. On this rested a mass of bones and implements imbedded in silt or sand, and sealed over by a thickness of stalagmite of from two to eight inches.

FIG. 32.—Bronze Knife, Heathery Burn (natural size).

On removing the upper of these two stalagmitic floors a perfect human skull was discovered, along with broken bones of animals, charcoal, limpet shells, bone pins, an instrument of bone like a paper-knife, coarse pottery with fragments of chert imbedded in its mass, a portion of a jet armlet, as well as several boars' tusks. The same stratum at another place furnished a singular bronze knife with a socket for the handle (Fig. 32),[1] bronze pins, celts, an armlet of twisted wire (Fig. 33), along with shells of limpet, mussel, and oyster, and charcoal, and at a third, on the other side of the watercourse, a bronze

[1] This woodcut, as well as Figs. 33 and 35, have been kindly lent by the Council of the Society of Antiquaries.

FIG. 33. – Bronze Armlet, Heathery Burn.

FIG. 34. —Bronze Spear-head, Heathery Burn ($\frac{1}{2}$ size).

FIG. 35. — Bronze Mould for casting a socketed celt.

spear-head. Subsequently, many articles were added to the above list, seven pins, three rings, two split-rings, a "razor," disk, three socketed celts, one chisel, two gouges, and four spear-heads of bronze, and a fine bracelet, and two ornaments of the horse-shoe, or split-ring type, made of thin plates of gold. One of the spear-heads, in the collection of the Rev. Canon Greenwell, is represented in Fig. 34. There were also waste pieces of bronze, and the half of a bronze mould for casting celts, Fig 35, in which one of the associated celts had actually been cast, since it is of the same pattern. These articles were probably concealed in the cavern by workers in bronze, who were prevented, by some unforeseen accident, from obtaining them again. The charcoal and the broken bones of the *Bos longifrons*, badger, and dog, imply that the cave had been used as a habitation; and possibly the two human skulls, which have been described by Professor Huxley and Mr. Carter Blake, may have belonged to the possessors of the hoard of bronze and gold. Both were discovered in the same stratum and below the floor of stalagmite.

The more perfect of the two skulls is considered by Professor Huxley to belong to the same long-headed race of men as that found at Muskham, in the valley of the Trent,—to a form which he terms the River-bed type, and that cannot be separated from those obtained from the long tumuli of the South of England, and considered by Dr. Thurnam to belong to a Neolithic Basque, or Iberian population.

Articles distinctly of the bronze age have been already noticed as having been met with in the caves of Kirkhead, in Cartmell, and in Thor's Cave, in Staffordshire. From the latter the bracelet of thin bronze, Fig. 31, was

obtained by Mr. Carrington, of Wetton. The rarity of bronze implements in caves in Britain and the Continent is probably, to a large extent, due to the value of the material, and to the fact that it could be re-melted. If a bronze article happened to be broken, the pieces would naturally be kept for future use, and not thrown away, as in the case of a fractured stone implement. The former, therefore, are rare, the latter comparatively abundant.

The cave called the Cat-Hole, in Gower (Glamorgan), explored by Colonel Wood in 1864, contained several human skeletons, flint flakes, fragments of red pottery marked with a string, cut bones, a stone muller, and a bronze socketed celt. The last is of the same pattern as some of those in the collection of the Rev. Canon Greenwell, from Heathery Burn, and has been cast in a mould similar in size and ornamentation to that figured in woodcut 35.

The Caves of Césareda probably occupied by Cannibals.

The contents of three caves[1] in the Iberian peninsula, referable to the dawn of the bronze age, render it very probable that the use of human flesh was not unknown in those times.

In 1867 Senhor J. L. Delgado described his researches in the caverns of Césareda, in the valley of the Tagus, in the Casa da Maura, Lapa Furada, and Cova da Maura.

[1] Commissao Geologica de Portugal. Estudos Geoligicos. Da Existencia do homen no nosso solo em Tempos mui remotos provada pelo estudos des cavernas. Primeiro opusculo. Noticea ácerca das Grutas da Césareda. Por J. F. N. Delgado com a versao em Francez por M. Dalhunty.

The first of these contained two distinct strata. The lower, consisting of sand mixed with fragments of rock, rested on the stalagmite, and contained fragments of charcoal, one implement of bone, and many of flint, a scraper, a flake, and an arrow-head. The broken bones and teeth belonged to the following animals :—The lynx, fox, brown-bear, dog and wolf, a species of deer, the water-vole, and the rabbit. None of the remains of the carnivora had been subjected to the action of fire, or had been used for food. A human skull with lower jaw was dug out of the deepest part, but, since the matrix had been disturbed, it had probably been interred after the accumulation of the deposit.

It is recognized by Professor Busk[1] as belonging to the same long type as the skulls of the caves of Gibraltar and the Basque graveyard, measuring in length 6·7 inches, in breadth 5·3, in height 5·5, and therefore possessing cephalic and latitudinal indices of ·785 and ·820.[2]

The upper stratum, a sandy loam, contained a large quantity of stones, and numerous articles fabricated by man: polished-stone axes, flakes, and other instruments of flint, bone, and antler, fragments of coarse black pottery, with bits of calcareous spar imbedded in its substance, and two plates of schist ornamented with a rude design, which may have been used as amulets. Fragments of charcoal were scattered throughout the matrix, and adhered to some of the pottery and to the burnt pebbles. The most abundant remains were those of man. They were to be counted by thousands, and were so fragmentary and scattered that it was impossible

[1] Ethnol. Journ. N.S. 7, p. 43.

[2] For definition of these terms, see p. 190.

to put together one perfect skeleton. The teeth, belonging for the most part to children or fully-grown adults, were particularly abundant. The long bones had lost, very generally, their articular ends, had been fractured longitudinally, and some of them had been cut and scraped. It is therefore probable that this accumulation was formed by a tribe of cannibals: the evidence that human flesh formed their principal food being precisely of the same nature as that by which the flint-folk of the Perigord are proved to have subsisted on the flesh of the reindeer. Professor Busk,[1] however, is inclined to believe the facts in support of cannibalism insufficient. The associated animals consisted of the bat, dormouse, rabbit, horse, a small ox, allied to *Bos longifrons*, sheep or goat, wild cat, wolf, fox, and dog. The contents of the other two caves were precisely of the same nature, and had been accumulated under the same conditions.

A bronze arrow-head, discovered in the upper stratum, and the ornamentation of the stone amulet, consisting of alternate triangles and zigzag ladders, as remarked by Mr. John Evans, indicate that the upper deposit belongs to the age of bronze, and probably to an early stage, when stone was being superseded by bronze, since many stone celts were found in the same spot.

The ancient burial-places of Ultz, in Westphalia, furnish a second case of the practice of cannibalism, according to M. Schaaffhausen of Bonn. They are probably of the age of bronze.

[1] International Congress of Prehistoric Archæology, Norwich Volume, p. 84.

[2] International Congress, Paris Volume, p. 159.

The Cave of Reggio, in Modena.

The human remains in a cave in the province of Reggio,[1] on the northern flank of the Apennines, brought before the Prehistoric Congress at Bologna by M. l'Abbé Chierici, and considered by him to be proofs of cannibalism, are probably merely the result of interment in a refuse-heap that had previously been accumulated. They were associated with bronze pins, rivets, polished-stone axes, and various implements of bone, fragments of pottery and of charcoal, bones of pig, sheep, and dog, and belong therefore to the period of transition from the neolithic to the bronze age.

The caves have contributed but very little to our knowledge of the bronze-folk in any part of Europe. Examples, such as those given above, are scattered through France and Spain, but they are not sufficiently important to require notice. We could not expect that men, in the high state of civilization implied by the beautiful jewellery and ornaments which are distinctive of the bronze-folk, would have chosen the wild, half-savage life which is involved in cave-habitation.

[1] Prehistoric Congress, Brussels Volume, 1872, p. 363.

CHAPTER V.

CAVES OF THE NEOLITHIC AGE.

Neolithic Caves in Great Britain.—The Refuse-heap at Perthi-Chwareu.—The Sepulchral Caves.—The Neolithic Caves in the neighbourhood of Cefn, St. Asaph.—The Chambered Tomb near Cefn.—Interments in Tomb and Caves of the same age.—Contents of Tomb and Caves.—Description of Human Remains by Professor Busk—From Cave No. 1 at Perthi-Chwareu—from Cairn at Cefn—from Cave at Cefn.—General Conclusions as to Human Remains.

It is evident, from the scanty remains found in caves, that they were not the normal habitations of men in the Bronze or Iron stages of culture. We shall, however, find that they were used by the neolithic peoples, both for shelter and for burial, in nearly every portion of Europe which has been explored.

Neolithic Caves in Great Britain.—Perthi-Chwareu.

The most remarkable examples of caves, turned to both these uses, in Britain, are offered by the group clustering round a refuse-heap at Perthi-Chwareu, a farm high up in the Welsh hills, about ten miles to the east of Corwen, and a mile to the west of the little village of Llandegla, in Denbighshire.

The Refuse-heap.

The first intimation of any prehistoric remains in that locality was afforded by a small box of bones forwarded to me by Mr. Darwin, in 1869; and this I was able to follow up, through the kind assistance of Mrs. Lloyd, the owner of the property on which they were found, from time to time, during 1869–70–71–2. The mountain limestone, which there forms hill and valley, consists of thick masses of hard rock, separated by soft beds of shale, and contains large quantities of *producti*, crinoids and corals. The strata dip to the south, at an angle of about 1 in 25, and form two parallel ridges, with abrupt faces to the north, and separated from each other by a narrow valley, passing east and west along the strike. The remains sent by Mr. Darwin were obtained from a space between two strata near the top of the northern ridge, whence the intervening softer material had been carried away by water. Its maximum height was 6 inches, and its width 20 feet or more; and it extended in a direction parallel to the bed of the rocks. The bones, which had evidently been washed in by the rain, and not carried in by any carnivora, belong to the following species:—

Canis familiaris—The Dog.
Canis vulpes—The Fox.
Meles taxus—The Badger.
Sus scrofa—The Pig.
Cervus capreolus—The Roe-deer.
Cervus elaphus—The Red-deer.
Capra hircus—The Goat.
Bos longifrons—The Celtic Short-horn.
Equus caballus—The Horse.
Arvicola amphibius—The Water-rat.
Lepus timidus—The Hare.
Lepus cuniculus—The Rabbit.
The Eagle.

Nearly all the bones were broken, and belonged to young animals. Those of the Celtic short-horn, of the sheep or goat, and of the young pig, were very abundant; while those of the roe and stag, hare and horse, were comparatively rare. The remains of the domestic dog were rather abundant, and the percentage of young puppies implies also that they, like the other animals, had been used for food. Possibly the hare may also have been eaten, but its remains were scarce, and belonged to adults. Some of the bones had been gnawed by dogs. The only reasonable cause that can be assigned for the accumulation of the remains of these animals is, that the locality was inhabited by men of pastoral habits, but yet to a certain extent dependent on the chase, and that the relics of their food were thrown out to form a refuse-heap. The latter had altogether disappeared from the surface of the ground, from the action of the rain and other atmospheric causes, while those portions of it which chanced to be washed into the narrow interspace between the strata were preserved, to mark the spot which it once occupied.

There was nothing in the deposit that fixes the date of its accumulation. It may have been of the stone, bronze, or iron age; but from the presence of the goat, short-horned ox, and dog, it certainly does not date so far back as the epoch of the reindeer, mammoth, rhinoceros, and cave-hyæna. The presence of the Celtic short-horn throws no light upon the antiquity, because for centuries after it had ceased to be the domestic breed in England it remained in Wales, and still lives in the small black Welsh cattle, that are lineal descendants of those which furnished beef to the Roman provincials in Britain.

The Sepulchral Caves.

While the refuse-heap was being explored, I chose a small depression (Fig. 36 A) in the precipitous side of the southern ridge, that formed a kind of rock shelter overlooking the valley, and that seemed to be a likely place for the abode of man, or of wild animals. On setting the men to work, in a few minutes we began to discover the remains of dog, marten-cat, fox, badger, goat, Celtic short-horn, roe-deer and stag, horse, and large birds.

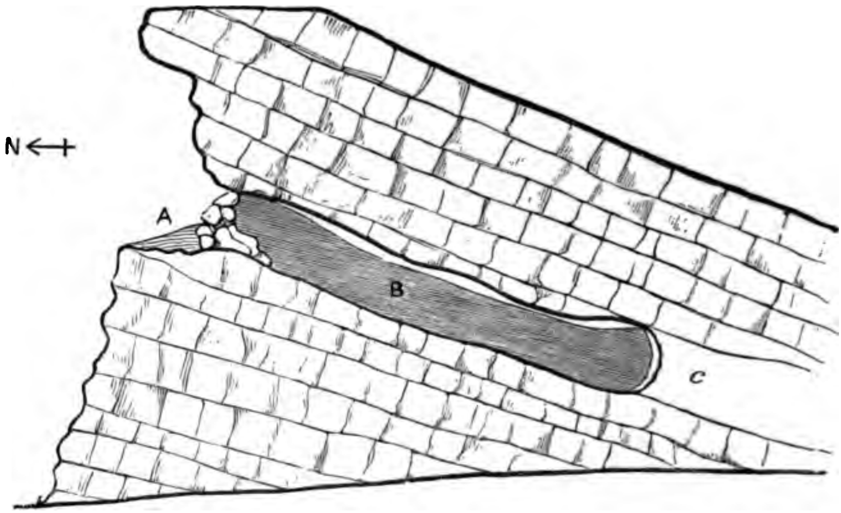


FIG. 36.—Section of Cave at Perthi-Chwareu. Scale 12 feet to 1 inch.

Mixed with these, as we proceeded, we began to find human bones, between and underneath large masses of rock, that were completely covered up with red silt and sand. As these were cleared away, we gradually realized that we were on the threshold of a sepulchral cave. In the small space then excavated, human remains, belonging to no fewer than five individuals, were found. Sub-

sequently the work was carried on by Mrs. Lloyd, under the careful supervision of her agent Mr. Reid. The rock-shelter narrowed into a "tunnel cave," that penetrated the rocks in a line parallel to the bedding, and, roughly speaking, at right angles to the valley, having a width varying from 3 feet 4 inches to 5 feet 6 inches, and a height from 3 feet 4 inches to 4 feet 6 inches.

The entrance was completely blocked up with red earth and loose stones, the latter, apparently, having been placed there by design (Figs. 36, 37). The inside of the cave was filled with red earth and sand to within about a foot of the roof. The remains were found, for the most part, on or near the top; but in some cases they were deep down. One human skull, for example, was found six inches only above the rocky floor. The human bones were associated with those of the animals of which a list has been given, and occurred in little confused heaps. One human femur was in a perpendicular position. The account of the continuation of the digging is given almost in the words of Mrs. Lloyd. On the second day, after an hour's work, a human skull was found near the roof of the cave, resting on a femur; then eleven feet explored brought to light a large quantity of human bones, including nine femurs. The third and fourth days were devoted to clearing out the cave (Fig. 36-7 B) up to this point, and to excavating about four feet further in, or fifteen from the entrance. During the work two teeth of a horse were found, resting on the floor near the entrance, and nine more about ten feet within the cave; also a boar's tusk of remarkable size, and close by a mussel and cockle-shell, and valve of *Mya truncata*, along with a quantity of human and other bones; including five skulls, more or less perfect,

and many fragments. All these skulls were found between the tenth and fifteenth feet from the entrance. During the fifth and sixth days, the work was superintended by Mr. Reid, who entirely cleared the cave for about thirteen feet further: the first eight feet yielded a small quantity of human and other bones, including the

FIG. 37.—Plan of Cave at Perthi-Chwareu.

perfect skull of a marten-cat and the incisor of a wild boar. The only implement found in the cave, a broken flint flake, occurred here, and a nearly perfect human skull, lying face downwards, with the pelvis adhering to one side. The last five feet furnished only two bones, both of the short-horned ox. The end of the cave was composed of unproductive grey clay. (Figs. 36-7 c.)

Small fragments of charcoal occurred throughout the cave, and a great many rounded pebbles from the boulder clay of the neighbourhood.

The human remains belong for the most part to very young or adolescent individuals, from the small infant to youths of twenty-one. Some, however, belong to men in the prime of life. All the teeth that had been used were ground perfectly flat. The skulls belong to that type which Professor Huxley terms the "river-bed skull." Some of the tibiæ present the peculiar flattening parallel to the median line, which Professor Busk denotes by the term platycnemic, and some of the femora were traversed by a largely developed and prominent *linea aspera;* but these peculiarities were not seen on all the femora and tibiæ, and cannot therefore be considered characteristic of race, but most probably of sex. They were not presented by any of the younger bones.

All the human remains had undoubtedly been buried in the cave, since the bones were in the main perfect, or only broken by the large stones which had subsequently fallen from the roof. From the juxtaposition of one skull to a pelvis, and the vertical position of one of the femora, as well as the fact that the bones lay in confused heaps, it is clear that the corpses had been buried in the contracted posture, as is usually the case in neolithic interments. And since the area was insufficient for the accommodation of so many bodies at one time, it is certain that the cave had been used as a cemetery at different times. The stones blocking up the entrance were probably placed as a barrier against the inroads of wild beasts.

These remains are the first in this country which present the peculiar character of platycnemism, noticed

by Professor Busk and Dr. Falconer in human remains in the caves of Gibraltar, and by Dr. Broca in some of those from the dolmens of France, and subsequently in the celebrated skeletons found in the cave of Cro-magnon. I have also observed the same peculiar flattening of the tibia in the only fragment of human bone obtained by Mr. Foote, in the Lateritic deposits of the eastern coast of Southern India, along with the stone implements figured in the Norwich Volume of the International Congress of Prehistoric Archæology (1868, p. 224).

The remains of the animals associated with the human bones belong to the same species as those mentioned above from the débris of a refuse-heap, and are in a similar broken and split condition. They may have been deposited at the same time as the human skeletons, but, from the fact that some of them are gnawed by dogs, it is most probable that they were accumulated while the cave was used as a dwelling. If the bodies were placed on an old floor of occupation, and afterwards disturbed by rabbits and badgers, the remains would be mingled together as they were found to be mingled. The contents had evidently been disturbed by the burrowing of all these animals.

Subsequently we discovered and explored no less than four other sepulchral caves, within a few hundred yards of the refuse-heap, in which the corpses had been buried in the same crouching posture. From one on the farm of Rhosdigre we obtained a perfect celt of polished greenstone which had never been used (Fig. 38), together with several flint flakes, and numerous fragments of pottery, rude, black inside, hand-made, and containing in their substance small fragments of limestone.

Similar potsherds are preserved in the Oxford Museum, from the superficial deposits of the caves of Gailenreuth and Kuhlock, and I have observed them also among the remains from Kent's Hole. The celt was most probably, from its unworn condition, buried with the dead,

FIG. 38.—Greenstone Celt, Rhosdigre Cave. (Nat. size.)

and it stamps the neolithic age of the interments of the whole group.

Among the broken bones from this cave were the teeth of the brown bear, and the lower jaw of a wolf; and the fractured bones of the dog implied that that animal

ministered to the appetite, as well as obeyed the commands, of the neolithic inhabitants. I have met with similar evidence of the use of dog's flesh for food among the broken bones which Canon Greenwell obtained from the neolithic tumuli of the Yorkshire Wolds. On the other hand, the marks of the teeth of dogs, or wolves, on some of the human femora, implied that those animals made their way into this cave and feasted on the corpses.

The neolithic age of these interments is proved, not merely by the presence of the stone axe, or of the flint flakes, but by the burial in a contracted posture,[1] and the fact that the skulls are identical with those obtained from chambered tombs in the south of England proved to be neolithic by Dr. Thurnam.

The number of skeletons of all ages, and of both sexes, buried in these caves was very considerable; and they had been placed on the old floor of occupation at successive times. In that of Rhosdigre the accumulation of charcoal, broken bones, and fragments of pottery below some of the human skeletons, proved that it had been used for a habitation before it was used for a burial-place. It is very probable that originally the head of a family, or a clan, or a tribe, was buried in his own cave-dwelling, and that it was afterwards used as a cemetery for his blood relations and followers.

[1] Burial in the contracted posture, which is so characteristic of the neolithic age, was probably due, as is suggested by my friend Mr. John Evans, F.R.S., to the habit of sleeping in that posture and not at full length on a bed. The body was not laid out after death, but may have been folded together, as in the case of the ancient Peruvian mummies. No regularity, however, in the contracted posture could be observed in the many tumuli and caves which I have explored, although very generally the corpse had been interred on its side.

The Neolithic Caves in the neighbourhood of Cefn, near St. Asaph.

The same class of remains, referable to the neolithic age, have been met with in the caves in the limestone cliffs of the beautiful valleys of the Clwyd and the Elwy, near St. Asaph. In the collection of fossil bones in the possession of Mrs. Williams Wynn, discovered in 1833, in a cave at Cefn, by Mr. Edward Lloyd,[1] is a human skull and lower jaw, along with platycnemic limb-bones. They were found mingled with the bones of goat, pig, fox, and badger, and cut antlers of the red-deer, inside the lower entrance of the cave, in which the extinct pleistocene animals were found in the valley of the Elwy. Four flint flakes also were discovered along with them.

The skull in its general features strongly resembles those found in the group of caves at Perthi-Chwareu, and presents a cephalic index[2] of ·770, which comes within the limits of the extreme forms from that locality. Professor Busk, however, as will be seen in his account of this skull, because of its low altitudinal index—·702, as compared with ·710 of the lowest Perthi-Chwareu skull—is inclined to view it as of a different type. The conditions, on the other hand, under which it was found appear to me to be circumstantial evidence that the interment is of the same relative age as that of Perthi-Chwareu. Both were in caves: in both the remains of the same domestic and wild animals were found in the same fragmentary condition. Flint flakes also occurred in both; and what is more important, the platycnemic

[1] Edinburgh New Phil. Soc. (1833), No. 27, p. 40.

[2] For the definition of the term, see p. 190.

limb-bones in both imply a somewhat similar mode of life in the people to whom they belonged. This body of evidence, in favour of the interments having been made by the same race of men who lived some time in Denbighshire, seems to me of greater weight than that to the contrary afforded by the difference of ·008 in the altitudinal indices of the skulls. After a comparison of the carefully prepared measurements of the crania published in the "Crania Britannica" with those published elsewhere, I cannot resist the conviction, that if similar modes of life and of burial in Britain imply an identity of race, cranial variation within the limits of that race is by no means very small. Absolute purity of blood in an island so near the Continent as Britain cannot be looked for ; and unity of type resulting from isolation from other races, such as that presented by the Australians, is not likely to be met with. It is therefore very probable that some of the variations may be accounted for by the blending of different ethnical elements in one race. I am consequently inclined to view the interments in these two caves as having been made by the same people, in spite of the small cranial difference manifested by the Cefn skull.

The cave in Brysgill, a small ravine leading into the valley of the Elwy, explored by Mr. Mainwaring and Mrs. Williams Wynn in 1871, furnished evidence of the occupation of man, probably of the neolithic age. From a dark layer composed of loam, black with fragments of charcoal, a flint arrow-head, a core, a flake, and broken bones of the horse, *Bos longifrons,* goat, and dog, were obtained, as well as a few human bones which had not been broken by design.

The excavations carried on in the small tunnel-cave of Plas-Heaton, by Mr. Heaton and Professor Hughes,

have shown that it was inhabited at two different ages. In the upper or prehistoric stratum were broken bones of the dog, badger, goat, *Bos longifrons*, and stag; while in the lower, or pleistocene, were the remains of the hyæna, reindeer, cave-bear, and the lower jaw of the glutton.

The Chambered Tomb near Cefn, St. Asaph.

While the caves at Perthi-Chwareu were being explored, the accidental discovery of human remains in the cairn of Tyddyn Bleiddyn, near Cefn, St. Asaph, in 1869, led to a systematic examination of its contents by Mrs. Williams Wynn, under the superintendence of the Rev. D. R. Thomas, myself, and the Rev. H. H. Winwood, which has resulted in the proof, that the people who buried their dead in caves used stone-chambered tombs for the same purpose.

The cairn of loose fragments of limestone had been removed for road-mending before the cap-stones of the stone chamber were exposed, and these were broken before any scientific observation was made. The Rev. D. R. Thomas, however, rescued many of the human remains from destruction, and began the exploration which defined the extent of the chamber A (Fig. 39).

Subsequently it was resumed in my presence, and the chamber A (Fig. 39) fully cleared out. At the point *c* it was partially shut off from the passage B by a slab of stone 18 inches high. The passage led from the chamber in a northern direction, and was 6 feet long by 2 wide. The chamber gradually narrowed towards the passage, being 5 feet wide at its broad end, and 9 feet long. In the passage, as well as in the chamber,

there were human bones belonging to individuals who had been buried in a crouching posture. Unfortunately, as the remains have been scattered, it is impossible to ascertain the exact number of the burials. I have, however, restored one skull and examined seven frontal bones, and other remains, which indicate that there were at least twelve persons, varying in age from infancy to full prime, buried in this tomb. In addition to these, there is a large box of bones in the possession of the Rev. D. R. Thomas, as well as other remains in other hands. But although the exact number of bodies interred cannot be made out, there is full proof that there were too many to have been deposited at one time in so small a cubic area; and therefore they must have been deposited at different times, as in the caves at Perthi-Chwareu. There were no remains of either wild or domestic animals; and the only foreign object was a small slightly chipped flint pebble. From the remarkable conformation of the nasal bones of some of the skulls, it would seem likely that the burial-place belonged to one family; but, for a reason (see Notes on Human Remains, p. 183) stated by Professor Busk, this is by no means a certain inference.

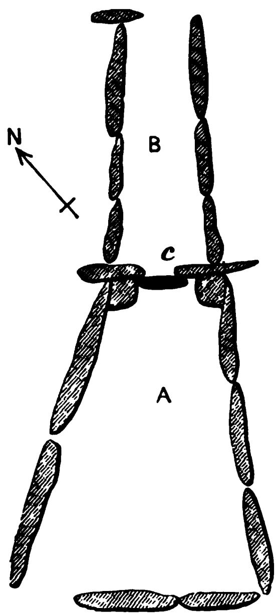


FIG. 39.—Plan of Chambered Tomb at Cefn.

The plan of the chamber and passage corresponds with that of the long barrow of West Kennet, figured in the "Crania Britannica," and with that of the crom-

lech of Le Creux des Fées, Guernsey, described by Lieutenant Oliver.[1] In the former of these the corpses were buried in a contracted posture, along with flint scrapers and fragments of rude pottery. In the latter the original contents have disappeared. To speak in general terms, the chamber and passage belong to the class of tombs which Dr. Thurnam names "Long Barrows," and Professor Nilsson "Ganggräben," and which are found in Scandinavia and France, as well as in Britain. And it is worthy of note that the partial insulation of the chamber A (Fig. 39) from the passage B by a slab (*c*), which does not reach up to the height of the walls, is to be seen in similar tombs both in Guernsey and in Brittany.

A second and larger chamber, composed of cave slabs of limestone, was discovered in the same cairn in 1871 by the Rev. D. R. Thomas, and completely excavated by him along with myself and the Rev. H. H. Winwood. It was of a rudely triangular form, 10 feet long by 6 wide, traversed by a partition of slabs, and provided with a narrow passage 10 feet long by 2 feet 6 in width, opening to the north, and fenced off completely from the chamber by a slab, as in the preceding case. Both the chamber and the passage were full of human remains of all ages, buried in a contracted posture; the number of interments being far too great to have allowed the bodies to have been deposited at one time. From the former I identified the broken jaw of a roebuck and remains of goat, a broken flint, and round pebbles of quartz, while in the latter there were the teeth and bones of the dog and the pig.

[1] Journal of the Ethnological Society of London, vol. ii. New Series, No. 1, April 1870, p. 45, pl. vii. fig. 3.

Some of the tibiæ from both the chambers were platycnemic, but that character was only to be recognized in the older bones. The skulls, from the second of the two chambers, agree so exactly with those from the caves, that it is not necessary to add to the table of measurements which Professor Busk has drawn up (p. 171).

Correlation of Chambered Tomb with Interments in the Caves of Perthi-Chwareu and Cefn.

Nor are we without evidence that the builders of this cairn belonged to the same race as those who buried their dead in the caves of Perthi-Chwareu and of Cefn. The crania and the limb-bones are identical, and in both the tombs and caves the dead were buried in a contracted posture.

Why then, it may be asked, were the remains of animals so rare in the one and so abundant in the other? In my opinion this difference may be explained by the hypothesis, invented by Professor Nilsson, of the origin of chambered tombs.[1] The idea of the "gallery graves," according to that high authority, was derived from the subterranean house in which the deceased lived, and in which he was buried after his death, after the fashion of the Eskimos at the present day. The plan of the houses, like that of the ancient Lycian dwellings described by Sir Charles Fellowes, was preserved in the tombs, and probably for many ages after houses were no longer made in that fashion; since the principle of conservatism and the force of custom are more deeply

[1] Nilsson's "Stone Age," translated by Sir J. Lubbock.

rooted in religious and solemn ceremonial than in the changes of every-day life.

The rarity of the remains of the animals may be explained by the fact of these tombs never having been used as dwellings, while their abundance in the caves may be accounted for by the latter having been inhabited by man, and thus the idea of the dead resting in his own house would be the cause of burial both in caves and chambered tombs. It is not at all strange that the same race should have used both for sepulture, when we consider that a "gallery grave" is an artificial cave, and that natural caves are few in number.

This ancient race is proved by the remains to have been pastoral, rather than dependent on the chase, their principal food being the domestic goat, the short-horn (*Bos longifrons*), the horse, and hog. They are also proved to have been neolithic, not merely by the discovery of a polished stone axe in one of the caves, but also by the shape of the "gallery graves," which Professor Nilsson and Dr. Thurnam agree in referring to that stage of culture.

Table of Contents of Caves and Chambered Tomb.

The contents of the caves and the stone chambers may be gathered from the Table which we give on the next page.

The broken bones of the hare prove that there was no prejudice against its flesh, as was the case among the neolithic dwellers in the Swiss Pfahlbauten. We shall see in the next chapter that the animal was also eaten by the dwellers in the neolithic caves both of France and Belgium.

List of Objects in Neolithic Caves and Cairn in North Wales.

ANIMALS.	Refuse-heap, Perthi-Chwareu.	Cave No. 1.	Cave No. 2.	Cave Rhosdigre, No. 1.	Cave Rhosdigre, No. 2.	Cave Rhosdigre, No. 3.	The Cefn Cave.	Cairn of Tyddyn Bleiddyn, near Cefn.
DOMESTIC.								
Canis familiaris —Dog	×	×	×	×	×	×		×
Sus scrofa—Pig	×	×	×	×	×	×	×	×
Equus caballus—Horse	×	×	×	×	×	×		
Bos longifrons—Celtic Short-horn	×	×	×	×	×	×		
Capra hircus—Goat	×	×	×	×	×	×	×	×
WILD.								
Canis lupus—Wolf				×				
Canis vulpes—Fox	×	×	×	×	×		×	
Meles taxus—Badger	×	×	×	×	×		×	
Ursus arctos—Bear				×				
Sus scrofa—Wild Boar		×						
Cervus elaphus—Stag	×	×		×				
Cervus capreolus—Roe	×	×						×
Lepus cuniculus—Rabbit	×	×	×	×	×			
Lepus timidus—Hare	×	×		×	×			
Polished Celts				×				
Flint Flakes or Chips		×		×			×	×
Pottery				×	×	×	×	
Human Skeletons		×	×	×	×	×	×	×
Platycnemic bones		×	×	×	×	×	×	×

Description of the Human Remains by Professor Busk.

For the following account of the human remains, reprinted from the "Journal of the Ethnological Society," January 1871, I am indebted to the kindness of my friend Professor Busk, to whom examples of all the forms were forwarded:—

Notes on the Human Remains. By Professor BUSK, F.R.S.

§ 1. INTRODUCTION.

The remains discovered in the sepulchral cave at Perthi-Chwareu, according to a list furnished by Mr. Boyd Dawkins, are as under; but

I believe this catalogue does not include all that were found in the locality.[1]

1. Eleven more or less perfect skulls, some, however, represented by mere fragments.
2. Twelve mandibles.
3. Seven arm-bones or *humeri*—four right and three left.
4. Six *ulnæ*.
5. Twenty-two thigh-bones, including five pairs, five odd ones of the right side, and seven of the left; and amongst them are three of very young children.
6. Seventeen *tibiæ* or leg-bones, nine of the right and eight of the left side, and apparently none of them in pairs; so that there must probably have been a good many more.
7. Eight *astragali*.
8. Nine *calcanea*, or heel-bones.

The number of individuals, therefore, whose relics were deposited in this cavern could not have been less than sixteen, and may have been many more. They appear to have been of all ages and of both sexes.

Of the other bones of the skeleton, of which there must have been abundance, I have received no information.

In the Cefn Cave there were discovered:—

1. One mandible.
2. One *humerus*.
3. Two *ulnæ*.
4. A pair of thigh-bones.
5. A pair of leg-bones.

and in the tumulus:—1. Portions of seven skulls.
2. Two right *humeri*.
3. A pair of *ulnæ*.
4. A right *femur*.

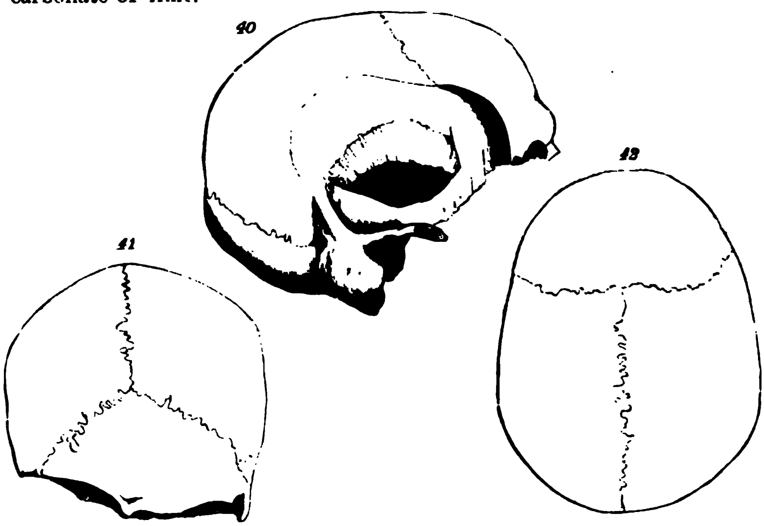
From St. Asaph the only bone that has come under my observation is a single *calvaria*.

§ 2. Description of the Bones from the Cavern at Perthi-Chwareu.

(a.) *General Condition.*—In general condition, as regards colour and texture, these bones present some, but no very striking, differences;

[1] These are merely samples of the large number of human skulls and bones which were discovered.

on the whole they are much alike, though it might be supposed that some have lain longer in the ground than the others. One or two among them (but these are apparently the younger bones) are fragile; the majority, however, are as firm as common churchyard bones, and some have quite the natural degree of hardness. They are of a lightish-yellow colour, do not adhere to the tongue, and afford scarcely any earthy smell when breathed upon or moistened: only one among them presents any staining from oxide of manganese; and this exists in diffuse blotches, and is not at all of the dendritic form. Many are partially covered with a very thin film of crystalline carbonate of lime.



FIGS. 40, 41, 42.—Skull from Sepulchral Cave at Perthi-Chwareu.

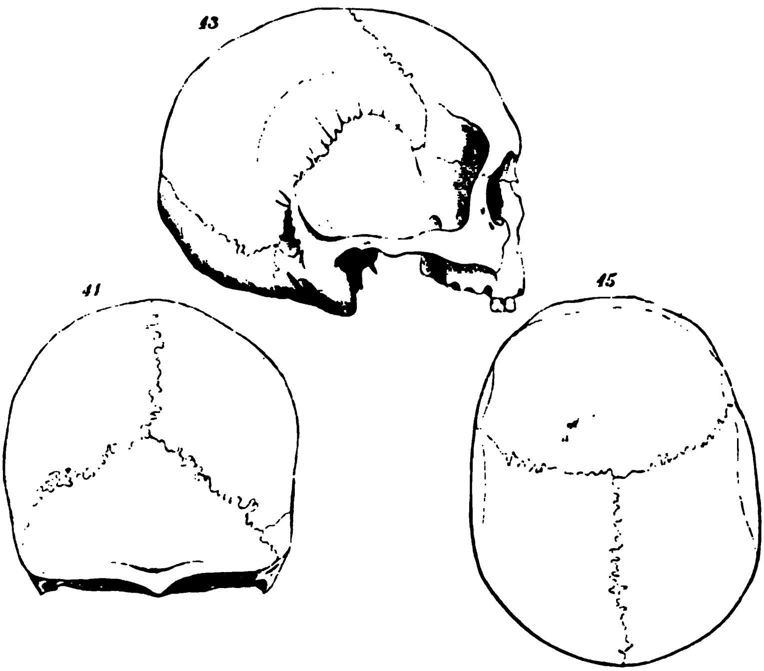
(b.) *The Skulls.*—Of these only three of the more perfect have come under my observation. These alone will form the subject of what I have to remark on this portion of the skeleton. But in the subjoined Table I. (p. 171) I have given, together with the dimensions of these three, those of five others which have been furnished to me by Mr. Dawkins.

In the specimen No. 1 (Figs 40, 41, 42) the entire facial part is wanting, together with the whole of the base and a great part of one side of the *calvaria*. The skull is of an oval form, symmetrical, with a rather prominent occiput. The region of the vertex is slightly and evenly arched; and the forehead, though not high, is vertical, and

slightly compressed on the sides. The sutures are all open and finely serrated. The frontal sinuses are distinct though small. The supra-orbital ridge is thin, but rather prominent towards the external angular process. The mastoid processes are very large, and the digastric *fossa* remarkably deep. The occipital spine is very prominent, as are the lateral ridges. The temporal ridges, also, and, in short, all the muscular impressions, are very strongly marked.

The skull is evidently that of a powerful, muscular man, in the prime of life, and apparently of robust, but not coarse build.[1]

43



44 45

FIGS. 43, 44, 45.—Skull from Sepulchral Cave at Perthi-Chwareu.

Skull No. 2 (Figs. 43, 44, 45) is that of an adult male, presenting as nearly as possible the same dimensions, form, and other characters as that above described, except that the bone is somewhat thicker and heavier. The muscular ridges and impressions are even more strongly

[1] Amongst the Keiss crania described by Prof. Huxley, this most closely resembles his No. 5; but it is of the same type as No. 3 and No. 7, and not very far from that of the Towyn-y-capel cranium, through which the transition to the Mewslade form ("Nat. Hist. Rev." vol. i. p. 174, pl. v.) is very easy.

developed than in the former, and especially the temporal ridges immediately above the external angular processes. The left *maxilla* remains loosely attached, containing the two bicuspid teeth, which are of small size, and worn quite flat, and to such an extent as to render it probable that the man was somewhat advanced in years, although none of the sutures are closed. The face is strictly orthognathous, and the skull dolichocephalic and aphanozygous.[1]

Skull No. 3 is the entire *calvaria* of a very young individual. The two milk-molars remain on either side; and behind them the first true molar is fully out, but not in the least worn. The incisors and canines have fallen out. The former, from the size of the *alveoli*, were of the permanent set, but not the latter. The age of the individual, therefore, may be estimated as about seven or eight.

The only point worthy of notice in this *calvaria* is the existence of a well-marked depression across the middle of the occipital bone, which appears exactly as if it had been caused by the constriction of a bandage. The depression barely extends beyond the lambdoidal suture into the parietals. It requires, perhaps, some imagination to perceive the slight traces of a corresponding depression in the fore-part of the skull; but I think a faint depression may be there perceived on careful inspection. The effect of the occipital constriction, if it be such, reminds one of some of the deformed French skulls described by M. Foville[2] and by M. Gosse.[3] In all other respects the skull is well formed and symmetrical. It is strictly orthognathous, and of a broad oval shape.

If deformed artificially, it would come under the head of "tête annulaire" of M. Gosse; and Dr. Foville shows that this kind of deformation arises from the popular custom of applying a kind of bandage round the head of the new-born infant, which, passing over the anterior fontanelle, descends obliquely, and is crossed behind the occiput and brought back and tied in front. This band, or "serre-tête," he states, is worn during the first year, and for a longer period by female children than by males. Dr. Lunier gives pretty nearly the same account, adding, however, further particulars.[4] It may be remarked, also, that the Berbers, who formed great part of the Moorish

[1] The forms most closely resembling this skull amongst those from Keiss are Nos. 3 and 7.

[2] Déformation du crâne resultant de la méthode la plus générale de couvrir la tête des enfans. Paris, 1834.

[3] Essai sur les déformations artificielles du crâne, par L. A. Gosse, de Genève. Paris, 1855.

[4] Recherches sur quelques déformations du crâne observées dans le Département des Deux-Sèvres ("Ann. Médico-psychologique"). Paris, 1852.

TABLE I.—*Dimensions of Perthi-Chwareu Skulls.*

No.	Length.	Breadth.	Height.	Least frontal breadth.	Greatest frontal breadth.	Parietal breadth.	Occipital breadth.	Zygomatic breadth.	Frontal radius.	Vertical radius.	Parietal radius	Occipital radius.	Maxillary radius.	Fronto-nasal radius.	Circumference.	Longitudinal arc.	(a) Frontal.	(b) Parietal.	(c) Occipital.	Frontal transverse arc.	Vertical transverse arc.	Parietal transverse arc.	Occipital transverse arc.	Latitudinal or cephalic index.	Altitudinal index.
1. . .	7·5	5·7	—	4·0	5·0	5·5	4·6	—	—	—	—	—	—	—	21·2	—	5·0	5·5	—	12·0	13·0	14·0	12·0	·760	—
2. . .	7·6	5·7	5·4	4·0	4·9	5·5	4·8	—	4·9	5·0	5·2	4·4	—	3·7	21·6	15·9	5·5	5·6	4·8	13·0	13·5	13·8	12·4	·750	·710
3. . .	6·5	5·2	5·5	3·4	4·5	5·1	4·1	3·9	4·2	4·5	4·7	4·1	3·2	3·0	19·0	14·7	4·9	5·3	4·5	11·6	12·45	13·4	11·2	·800	·846
4. . .	7·4	5·8	5·8	3·9	5·0	5·8	4·4	4·7	4·4	4·6	4·7	4·3	3·9	3·6	23·5	16·9	5·0	5·0	6·7	11·0	13·0	14·0	12·0	·797	·797
5. . .	6·7	5·0	—	3·5	4·4	5·4	4·1	—	4·0	4·3	4·6	4·0	—	—	18·5	—	4·4	5·2	—	11·0	12·5	13·4	—	·746	—
6. . .	6·8	5·4	—	3·6	4·3	5·3	4·0	—	4·3	4·5	4·8	4·2	—	—	19·8	14·6	4·8	5·3	4·5	14·0	12·0	13·0	11·0	·794	—
7. . .	—	5·5	—	—	—	5·3	—	—	—	—	4·6	4·0	—	—	—	—	—	—	—	—	—	—	—	—	—
8. . .	7·0	5·2	—	3·6	4·4	5·2	4·1	—	4·1	4·3	4·5	4·1	—	3·4	19·5	—	4·5	4·9	4·8	11·0	11·5	13·0	12·0	·743	—
Mean* . .	7·07	5·5	5·6	3·8	4·64	5·4	4·3	—	4·3	4·5	4·7	4·2	3·5	3·42	20·0	15·3	4·9	5·2	5·0	12·0	12·5	13·5	11·8	·765*	—
Cefn Cave .	7·4	5·7	5·2	3·8	4·7	5·5	4·8	—	4·6	4·6	4·7	4·0	—	3·8	21·0	15·1	5·0	5·5	4·6	12·2	12·8	13·8	12·0	·770	·702
Cefn Tumulus	7·38	5·65	—	3·6	45	5·55	—	—	4·5	4·6	4·9	4·5	—	3·6	—	—	5·2	5·2	—	12·4	12·4	12·8	10·9	·765	—
Ditto . . .	7·2	5·6	5·7	3·6	4·35	5·5	4·35	4·6	4·45	4·8	4·9	4·3	—	3·7	20·1	—	5·0	5·0	4·9	12·0	13·1	13·25	11·5	—	—
Ditto . . .	7·5	5·4	5·9	4·0	4·6	5·35	4·35	4·9	5·0	5·0	5·05	4·35	4·2	4·2	20·9	—	4·9	5·6	4·6	12·8	13·25	13·25	10·5	—	—
Genista Cave, Gibraltar .	7·95	5·5	5·7	3·9	5·0	5·4	4·45	5·2	4·7	4·8	4·9	4·25	4·1	3·75	20·6	14·0	5·2	4·8	4·0	12·5	13·2	13·3	11·4	·748	·714
Ditto . . .	7·35	5·6	6·1	3·8	4·9	5·4	4·5	5·2	4·75	4·9	5·1	4·9	4·0	3·65	20·8	15·3	4·3	5·6	4·9	12·3	13·2	13·3	11·6	·761	·889

* In taking this mean, the cephalic index of the young skull, No. 3, is omitted; if included, the mean would be ·785.

forces that invaded Europe in the eighth, ninth, and tenth centuries, used to elongate the skull posteriorly and flatten the forehead.

(c.) *Thigh-bones.*—I have had an opportunity of examining only a single perfect specimen of the thigh-bones. This is an entire bone, 18·2 inches long, with a least circumference of 3·5. Its perimetral index[1] consequently is ·192, which is about the normal standard. The *linea aspera*, at the middle of the bone more especially, is very prominent, so that the bone may be termed, in some degree, carinated (Fig. 46). The shaft is straight; and the chief peculiarities, besides the prominent *linea aspera*, which it presents, are (1) an unusual compression in the antero-posterior direction in the upper part, for the extent of about three inches below the *trochanter minor*. At about two inches below that process, or at a point corresponding with the lower part of the insertion of the *pectineus* muscle, the shaft measures ·9 × 1·45, whilst in three other ordinary *femora* with which I have compared it, the bone at the corresponding part measures ·9 × 1·20, ·9 × 1·10, ·9 × 1·15, showing that the Perthi-Chwareu *femur* is unusually expanded laterally in the upper part of the shaft. The consequence is to give the bone at that part a peculiar aspect, which is especially seen in an acute internal angle, and one rather less acute externally, instead of the usually rounded internal and external borders. (2) The distal extremity appears to be rather disproportionately large as compared with a recent well-formed bone of the same length, the condyles measuring 2·5 × 3·3 instead of 2·4 × 3·05; and the lower part of the shaft is also somewhat expanded. But the chief peculiarity, as above remarked, is the compression of the shaft in the upper part. Besides the *linea aspera*, all the muscular impressions are strongly marked, and especially those for the insertion of the *gluteus maximus* and the *trochanter minor*. The neck is long and very oblique, and the head, upon which only a small portion of the articular surface is left, must have had a diameter of about 1·9.

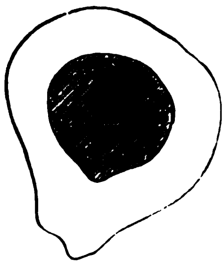


FIG. 46.

Mr. Boyd Dawkins has furnished me with the principal dimensions of several other *femora*, varying in length from 16 to 18 inches, and affording an average length of about 17, corresponding to a mean height of the individuals of about 5 ft. 4 in. to 5 ft. 5 in., the tallest being

[1] This index is obtained by dividing the least circumference by the length of the bone.

perhaps 5 ft. 6 in., and the shortest about 5 ft. 2 in., no doubt a woman. The mean perimetral index of the eight *femora* is ·186, which shows, in comparison with the usual thickness of well-formed male thigh-bones of the present day, a certain degree of slenderness. That this is not altogether owing to the circumstance that the bones include those of perhaps more than one female is proved by the fact that in no instance does the perimetral index exceed ·192, and in one thigh-bone, 18″·2 long, it is not more, if the circumference is correctly given, than ·178, the normal perimetral index for the adult male *femur* in this country being taken as about ·194.

(d.) *Tibiæ.*—Of the leg-bones brought under my notice, five are entire and five more or less defective. The principal dimensions and proportions of these bones, so far as they could be taken, are given in the subjoined Table.

TABLE II.—*Dimensions, &c., of Perthi-Chwareu Tibiæ.*

No.	Length.	Transverse diameter, proximal end.	Least circumference.	Antero-posterior diameter and transverse diameter of shaft.	Perimetral index.	Latitudinal index.
1.	14·9	2·8	3·2	140 × 80	·214	·571
2.	13·7	2·7	2·9	120 — 75	·211	·625
3.	13·2	3·0	3·0	135 × 80	·227	·592
4.	12·9	2·5	2·5	125 × 70	·193	·541
5.	12·9	2·5	2·75	100 × 70	·211	·700
6.	—	—	—	135 × 90	—	·666
7.	-	—	—	140 × 90	—	·642
8.	—	—	—	130 — 70	—	·538
9.	—	—	—	135 × 85	—	·629
Mean.	13·5	2·7	2·86	129 × 79	·211	·611

In this Table the *length* means the extreme length of the bone as measured from the summit of the spinous process to the point of the internal malleolus; and the numbers in the fifth column represent the antero-posterior and the transverse diameter of the shaft at the point where the popliteal line terminates at the inner border of the bone, which is usually about an inch and a half below the nutritive foramen. The *latitudinal* index represents the relation that the transverse diameter bears to the antero posterior, and it is employed to indicate, with some degree of precision, the actual amount of compression or flattening of the shaft as compared with the normal

form, which may, so far as my observations show, be taken for the ordinary English *tibiæ* as from ·700 or ·800, or in the mean at ·730, as will be seen in the subjoined Table, which contains the proportions of thirteen leg-bones taken indiscriminately from a drawer in the College of Surgeons.

TABLE III.—*Proportions, &c., of ordinary Tibiæ.*

No.	Length.	Transverse diameter, proximal end.	Least circumference.	Antero-posterior diameter and transverse diameter of shaft.	Perimetral index.	Latitudinal index.
1.	16·7	3·15	3·4	130 × 100	·202	·769
2.	16·4	3·2	3·5	150 × 115	·213	·766
3.	15·8	2·95	3·0	120 × 90	·189	·750
4.	15·5	2·95	2·9	140 × 90	·122	·642
5.	15·3	2·9	2·8	130 × 90	·150	·692
6.	15·2	3·0	3·2	140 × 90	·213	·642
7.	15·0	2·8	2·8	140 × 90	·187	·642
8.	15·0	2·6	2·8	120 × 85	·187	·709
9.	15·0	2·6	2·8	120 × 90	·187	·782
10.	15·5	3·0	2·9	120 × 95	·193	·791
11.	13·5	2·8	2·9	120 × 90	·214	·750
12.	13·4	2·75	2·7	120 × 85	·201	·708
13.	12·8	2·5	2·4	100 × 85	·187	·850
Mean	15·1	2·88	2·9	126 × 91	·188	·730

Comparison of the mean proportions given in the two Tables shows :—

(1) That the Perthi-Chwareu leg-bones are, on the whole, shorter, and absolutely smaller in all dimensions but one, viz. in the antero-posterior diameter of the shaft, which, notwithstanding the smaller size generally of the bones, is rather greater (that is to say, in the proportion of 129 to 126) than in the ordinary run of English *tibiæ*.

(2) That their perimetral index is greater, showing that, in proportion to their length, the Welsh bones are somewhat thicker, or in the proportion of 211 to 188.

(3) But the most marked difference is seen in the latitudinal index, which in the Perthi-Chwareu bones is ·611, and in those of the ordinary type ·730, varying in the former case from ·538 to ·700, and in the latter from ·642 to ·850; but the last is probably an exceptional case. In accordance with this, we find that the mean transverse

diameter of the shaft at the point above indicated is greatly under the usual mark, viz. as 79 to 91.

It is clear, therefore, that the Perthi-Chwareu *tibiæ* are more compressed or flattened than the usual run of modern European *tibiæ*; in other words, they belong to the platycnemic type.

As this is, I believe, the first instance in which the occurrence of *tibiæ* of this peculiar conformation has been observed in this country, the circumstance is of some interest, especially with relation to the occurrence of priscan bones of the same type elsewhere.

This peculiar conformation of the *tibia*, to which we gave the name of "platycnemic," was, I believe, first noticed by Dr. Falconer and myself, in 1863, in the human remains procured by Captain Brome from the Genista Cave, on Windmill Hill, Gibraltar, of which an account will be found in the Transactions of the International Congress of Prehistoric Archæology for the year 1868 (p. 161); and about the same time, or in May 1864, M. Broca[1] independently observed the same condition in *tibiæ* procured from the dolmen of Chamant (Oise), and afterwards in bones from the dolmen of Maintenon (Eure-et-Loire). Similar bones have since been noticed in other localities on the Continent, as, for instance, in the diluvium of Montmartre, by M. Eugène Bertrand. But that the peculiarity in question is not common in all the varieties of priscan man belonging to the reindeer period is shown by the fact that it has not been observed in any of the *tibiæ* exhumed by M. Dupont in the Belgian caves.

M. Broca's almost exhaustive remarks upon the anatomical, physiological, and pathological relations of this form of *tibia* leave but little to be said under those heads. I would, however, venture to add a few words as to its ethnological significance. But before doing so I would remark that there appear to be two forms of platycnemism, apparently indicative of some difference in the cause or nature of this aberration from the more usual shape of the bone. To save many words, I subjoin outlines of several well-marked instances of platycnemic bones, all drawn of the natural size and in the same position, the letter (*a*) in each corresponding to the interosseous ridge, and (*b*) to the *crista* or shin.

The line *b c*, drawn through the *crista* and the middle of the posterior surface of the bone, is bisected by another (*a d*), drawn at right angles to it, at the level of the interosseous ridge.

[1] "Mémoires sur les ossemens des Eyzies." Paris, 1868. "On the Human Skulls and Bones found in the Cave of Cro-magnon," Reliquiæ Aquitanicæ, p. 97.

In Fig. 47, which represents what may be regarded as a normal *tibia*, the length of that portion of the antero-posterior line which is behind the transverse line is to that of the anterior as 274 to 1,000,

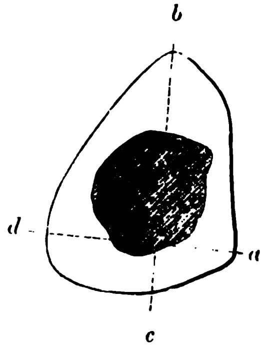


FIG. 47.

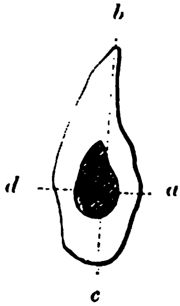


FIG. 48.

whilst in Fig. 48, taken from M. Broca's outline of the Cro-magnon *tibia*, which would seem to represent the extremest degree of platycnemism as yet observed, the proportion in question is as 623 to 1,000.

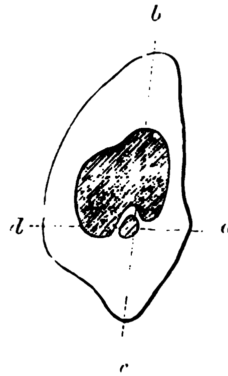


FIG. 49.

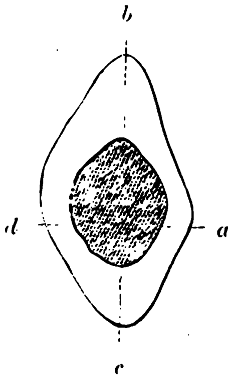


FIG. 50.

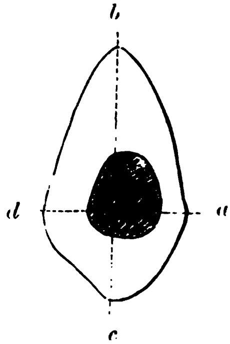


FIG. 51.

Figs. 49, 50, 51, are taken from as many of the Gibraltar *tibiæ*,[1] in which the proportion varies from 600 to 523, whilst it will be observed that in Figs. 52, 53, 54, taken from the most platycnemic of the Perthi-Chwareu *tibiæ*, the proportion in one only differs in any considerable

[1] But these are by no means extreme instances of the Gibraltar *tibiæ*.

degree from the extreme normal proportion shown in Fig. 47; and in this it is as 512 to 1,000, whilst in Fig. 53, which is nevertheless undoubtedly platycnemic, the proportion is exactly the same as in the most triangular form of bone.

It would seem, therefore, that platycnemism may arise from an unusual antero-posterior expansion of the bone, either in front or behind the level of the interosseous ridge. What this difference may indicate, or of what importance it may be in the consideration of questions relating to platycnemism, I am not prepared to discuss; but as in all probability it is connected with a difference in the cause of

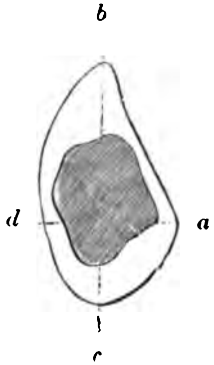


FIG. 52.

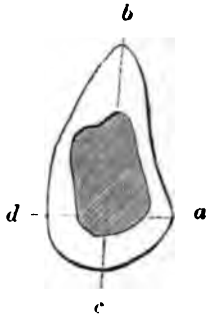


FIG. 53.

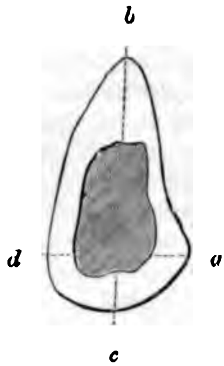


FIG. 54.

the deformation (if it be deformation), I have thought that the observation should be recorded, and would merely, in addition, remark that, so far as I have noticed, the occasional and not infrequent platycnemism observed in the shin-bones of negroes is what may be termed anterior.

With respect to the ethnological value of the platycnemic *tibia*, I conceive we are as yet very much in the dark. That it is a race-character would seem to me in the highest degree improbable, seeing that it would be difficult to find any other points of resemblance between the Cro magnon platycnemic men and those whose remains were met with in the Gibraltar caves, although the platycnemism is of the same kind in each; and still less could the former gigantic race be identified with the occupants of the Perthi-Chwareu sepulchre, from whom they differ not only in stature, but even more remarkably in cranial conformation.

If, then, platycnemism cannot be regarded as of any value as a race-character, it can *a fortiori* be still less looked upon as indicative

of simian tendencies, a notion that M. Broca seems somewhat inclined to favour. It is quite true that the *tibiæ* of the gorilla and of the chimpanzee are, to a certain extent, platycnemic; but it is by no means so much so as the human platycnemic bone. The *tibia* of a male gorilla in the College of Surgeons has a latitudinal index of ·681, and that of a female of ·650, whilst that of the chimpanzee is ·611, or exactly the mean of the Perthi-Chwareu bones. It is needless to insist upon the other marked distinctions between the simian and the human *tibia*; but as regards platycnemism it will be obvious, if we are disposed to trace it to any genetic descent, that the descendant has, in this respect, at one time far out-simianized the Simiæ

But this comparison with the anthropoid apes may, perhaps, afford ground for a suggestion respecting some possible connection between this peculiar form of the *tibia* and the habits of the people amongst whom it has been observed. One great distinction between the human and the simian foot consists in their respective adaptations to totally distinct functions. In the one case it is simply an organ of support and progression; in the other, for the most part, of prehension. This necessarily involves a considerable difference in the proportions, &c., of the muscles by which the greater mobility and adaptability of the foot, and more particularly of the digits, are ensured. Would it not, then, be admissible to inquire how far, at any rate, posterior platycnemism may be connected with the greater freedom of motion and general adaptability of the toes enjoyed by those peoples whose feet have not been subjected to the confinement of shoes or other coverings, and who at the same time have been compelled to lead an active existence in a rude and rugged or mountainous and wooded country, where the exigencies of the chase would demand the utmost agility in climbing and otherwise?

Some common cause of this kind would seem to be not improbable; and it would not, perhaps, be difficult to ascertain whether it is a *vera causa* or not. But, with respect to this, observations are at present wanting.

From the foregoing data we may conclude:—

(1) That the Perthi-Chwareu bones belonged to a race characterized by the proportionally rather large dimensions of the cranium, whose form presents nothing very remarkable, and is pretty nearly conformable to several of those found by Mr. Laing in the ancient shell-mounds in Shetland.[1]

[1] As regards the absolute dimensions of the skulls, it would seem that the Welsh crania stand high in the scale—quite as high as any of the existing races

(2) That this form is distinctly different from that of the Mewslade skull, in which the vertical region is somewhat flattened, as is the case also with several Anglesey crania, which, however, appear to pass, by gradual transition, into the Keiss and Perthi-Chwareu shape, through such a form as that of the Towyn-y-capel skull figured by Professor Huxley;[1] and the whole of them consequently may be regarded as belonging to the so-called "River-bed skulls" of that author, excepting the Borris cranium, which appears to belong to a different type altogether.

(3) That the people whose remains were found in this locality were of low stature (the mean height, deduced from the lengths of the long bones, being little more than 5 feet), the tallest being 5 ft. 6 in., and the shortest adult not more than 4 ft. 10 in., the intermediate ones being 5 ft. 1 in. and 5 ft. 2 in.

(4) That the proportions of the long bones are rather thick, and the muscular impressions in all are very strongly marked.

(5) That the *tibiæ* are, for the most part, of a much more compressed form than those of the modern English, but that this platycnemism does not appear to be exactly of the same kind as that which is exhibited in the Gibraltar bones and in those from Cro-magnon (as figured by M. Broca), the difference consisting in the fact that in the two latter instances the bone is expanded backwards behind the transverse plane at the interosseous ridge as much as it is in front of

of mankind. I have made the comparison in a rough way in the following manner :—

If the numbers representing the *length*, *breadth*, and *height* of the skull are added together, a number is obtained which will, of course, in some measure, indicate the gross dimensions of the skull. From the rather numerous data furnished by my own Tables of Measurements I obtained the results stated in the subjoined list, in which the gross mean dimensions of various sets of crania are contrasted.

1.	Scandinavian priscan skulls of the neolithic epoch	18·88
2.	Esquimaux and Greenlanders	18·81
3.	Perthi-Chwareu skulls	18·65
4.	Modern European	18·58
5.	Various ancient and priscan skulls	18·55
6.	Burmese	18·55
7.	Caffres and Zooloos (extratropical negroes)	18·45
8.	Derbyshire tumuli	18·42
9.	Tasmanian	17·95
10.	Hottentot	17·80
11.	Negroes (intertropical)	17·67
12.	Australian	17·58
13.	Bushmen	17·48
14.	Veddahs	17·09
15.	Andamanese	17·00

[1] "Notes on the Human Remains from Keiss," p. 85.

that plane, whilst in the Welsh *tibiæ* it is the anterior portion of the shaft only which is expanded; or, in other words, the platycnemism in them is due simply to an absolute compression of the shaft.

§ 3. Human Remains from the Cefn Tumulus.

These remains, as submitted to my inspection, consist of:—

(1) Portions of three frontal bones, two of which are nearly complete, and one constituted of little more than the superciliary region.

(2) Two parietals and a left temporal, probably belonging to the same skull as the more mutilated frontal.

(3) Portions of four thigh-bones, two left and two right, one of the latter wanting the proximal, the other both extremities.

We have thus the remains of three individuals from this interment.

I. *The Frontal Bones.*—No. 1. The least transverse diameter, immediately behind the external angular processes, is 3″·6, and its greatest (at the coronal suture) about 4″·3. Longitudinal arc, 4″·1. The profile outline of the forehead is slightly receding; the frontal sinuses moderately developed; and the supraorbital border thin and acute, whilst the glabellar eminence is large and prominent. The bone is a good deal compressed on the sides, so as to have almost the appearance of having formed part of a cymbecephalic skull. The bone itself is thin, and probably without any *diploë*.

No. 2 presents exactly the same characters, except that the longitudinal arc is greater, being 5″·3. The postorbital or least transverse diameter is 3″·4, and the coronal or greatest 4″·4. The frontal sinuses are well developed; the supraorbital ridge rather prominent, but thin and sharp; the external angular process prominent and thick. Glabellar eminence large and prominent. The nasals remain *in situ*, and project almost, if not quite, horizontally forwards, with a rapid curve at first, and then straight out. The general contour of the bone is exactly like that of No. 1, in which also, although the nasals are wanting, the position of the surface by which they were attached shows that they must in all probability have resembled those of No. 2. The *crista galli* of the ethmoid, which is left *in situ*, is remarkably thick and high.

No. 3 is a portion of a larger and wider bone, the postorbital diameter being at least 4″·0. The frontal sinuses are very large, but distinctly defined, as the remainder of the supraorbital border is not thickened. Owing perhaps to the greater prominence of the sinuses, the glabella does not appear so protuberant as in the other instances.

The nasal bones remain and project forwards in the same curious fashion as in No. 2. The frontal crest on the inner surface is remarkably developed, being at least half an inch high, though it is separated by a wide notch from the equally strongly developed *crista galli* of the ethmoid.

No. 4, when the three bones of which it is composed are put together, consists of the greater part of the parietal region of the skull, to which, as before said, the last-described frontal may have belonged. The left parietal is quite perfect; and a considerable portion of the right also remains, together with the entire left temporal; so that a very sufficient estimate of the proportions of the parietal region of the skull can be obtained.

As well as can be estimated, the parietal longitudinal arc, or length of the sagittal suture, is 5″·2. The vertical transverse arc, or that drawn from one auditory foramen to the other, over the point of junction of the coronal and sagittal sutures, is 12″·2, the parietal 13″, and the occipital 12″·2. In the temporal bone, the external auditory foramen is large, the mastoid process of moderate size, but the digastric fossa is wide and deep. The channels for the middle meningeal artery and its branches are large and deep; and very deep depressions on the sides of the sagittal suture show that the *glandulæ Pacchioni* must have been greatly developed. The bone is very thin, and with scarcely a trace of *diploë* where its structure is visible. None of the sutures, however, which are strongly serrated, are in the slightest degree closed, although, as I should imagine, the skull must have been that of a man beyond the middle period of life.

II. *The Thigh-bones.*—Two of these bones, which, though much alike, differ sufficiently to show that they did not belong to the same individual, are decidedly carinate.

No. 1 wants the upper and lower ends. The least circumference of the shaft, which is at a point about 3½ inches below the *trochanter minor*, is 3″·2. That process, as well as all the other muscular impressions, is strongly developed; and that for the insertion of the *gluteus maximus* is peculiar in presenting the form of a deep elongated pit instead of a roughened elevation as usual. The antero-posterior and transverse diameters of the shaft, about 1½ inches below the *trochanter minor*, are ·85 × 1·4; and the shaft at this part, like that of the above-described from Perthi-Chwareu, presents a rather acute or narrow external and internal border instead of the usual more rounded form. Lower down, the shaft becomes strongly carinate; and, owing to the flattened form of the anterior surface, its transverse section affords a subtriangular figure (fig. 55). The walls, or cortical substance, are

rather thicker than usual, and the substance of the bone is dense and hard.

No. 2 is very similar in character to the foregoing, but is not quite so much compressed in the upper part, measuring ·8 × 1·2. Nevertheless the inner border is very acute, and the outer more so than in

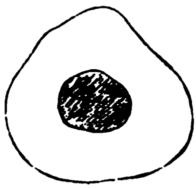


FIG. 55.

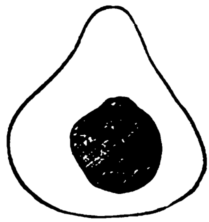


FIG. 56.

the common form of *femur*. The shaft lower down is not so strongly carinate as it is in the former instance, but is still so in some degree (Fig. 56); and the walls (or cortical substance) are still thicker in proportion.

No. 3. A third specimen consists of the lower half, or rather more, of the right *femur*. The least circumference is 3″·2. The bone exhibits no special external characters, and is in no degree carinated. The shaft, at about the middle of its length, is somewhat angular in front; and the pit for the origin of the *popliteus* muscle is deeper and

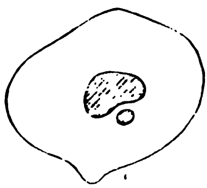


FIG. 57.

FIG. 58.

perhaps larger than in most bones of the same size. The texture of the cortical substance is quite eburneous; and it is extremely thick, so that the medullary canal is reduced to a calibre of little more than 0″·25 in its longest diameter. The shaft, however, is straight, and exhibits no other sign whatever of having been affected with *rachitis*. It is, however, a curious circumstance that many of the Gibraltar thigh-bones, most of which are carinate, present the same thickening of the cortical substance (Fig. 57).

No. 4. A fourth specimen is constituted of merely a portion of the shaft, about 12 inches long, and without either extremity. Its least diameter is 3″·3, and its antero-posterior and transverse diameters, at the same point as in the other bones, 1 × 1·25, or pretty nearly in the usual proportions. Nevertheless the bone, throughout its whole remaining extent, is less rounded on the inner side of the shaft than is usual. The *trochanter minor* is of gigantic size; and the shaft of the bone, about and below the middle, exhibits a subtriangular aspect (Fig. 58), though scarcely to be called carinate. The cortical substance is of the normal thickness.

III. *Tibiæ.*—No. 1 consists of the greater portion of the left tibia, wanting only the lower extremity. The proximal end measures 2·9 × 1·9; and the diameters of the shaft, about the middle, are 1·2 × ·75, giving a latitudinal index of ·620. The shin is remarkably sharp and prominent, and rather curved over to the outer side; and the apparent compression or tendency to platycnemism may in some measure be referred more to the production in front of the anterior part of the bone than to actual narrowing of the posterior side of the triangle, which is nevertheless rather more rounded than in most cases. The axis of the shaft is quite straight; and the bone has not the least rickety appearance.

No. 2 is also a portion of the left tibia. Both extremities are wanting, and the bone offers nothing worthy of remark. Its least circumference is 2″·65; and the shaft, at the middle, measures 1″·1 × ·65; so that the latitudinal index is about ·640, showing a slight degree of compression. The entire length of the bone may be estimated as rather more than 13 inches, corresponding to a height of about 5 ft. 4 in. or 5 ft. 5 in., so that the subject may be supposed to have been a female.

These remains represent at least four individuals—one probably somewhat aged, another of strong and robust make, and one, in all probability, a woman - in fact, a family group. No correct idea can be formed of the cranial conformation of these persons. In general shape it would seem to correspond with that of the Perthi-Chwareu skulls; but two of them at any rate are of smaller size, if we may judge from the least frontal diameter. The forehead also is perhaps a little more reclined. The most striking feature in two of the specimens, and which appears also to have existed in a third, is the extraordinary projection forwards of the nasal bones. In the present case this may probably be regarded as a family peculiarity; but with reference to it, it should be remembered that M. Broca[1] has

[1] *Loc. cit.* p. 114.

described a very similar condition in the skull of the "Old man" of Cro-magnon, in whom, he says, "the ridge of the nose, slightly depressed at its base, rises again almost immediately, and advances boldly forward, making a rapid curve, with the concavity directed rather forward and especially upward, so that the lower ends of the *ossa nasi* are placed 18 mm. (·7 inch) in front of a line dropped vertically from the fronto-nasal suture."

The condition of the bones from the Cefn tumulus differs very considerably from that of the remains from Perthi-Chwareu. They all have an appearance of much greater antiquity. With the exception of the very dense *femur*, they adhere to the tongue; and they are all deeply stained with manganous oxide, by which the substance even of the hardest portions is stained to a depth of more than one-eighth of an inch. That this discoloration, which for the most part does not assume the dendritic appearance, is due to manganese and not to any vegetable stain, is quite certain.

The form of the skull, so far as it can be ascertained from such imperfect remains, and the rather platycnemic shape of the *tibiæ*, may perhaps justify our supposing that the Cefn bones belong to a cognate race to those whose remains were deposited at Perthi-Chwareu, or to one which had lived under similar conditions. But the cranial data are hardly sufficient to allow of any satisfactory inference being drawn from them: and as regards the *tibiæ*, it has already been pointed out that platycnemism cannot, in the present state of our knowledge, be regarded as an important ethnological character amongst priscan peoples, though it may undoubtedly be considered a character betokening remote antiquity.

§ 4. Skull from the Cefn Cave, near St. Asaph.

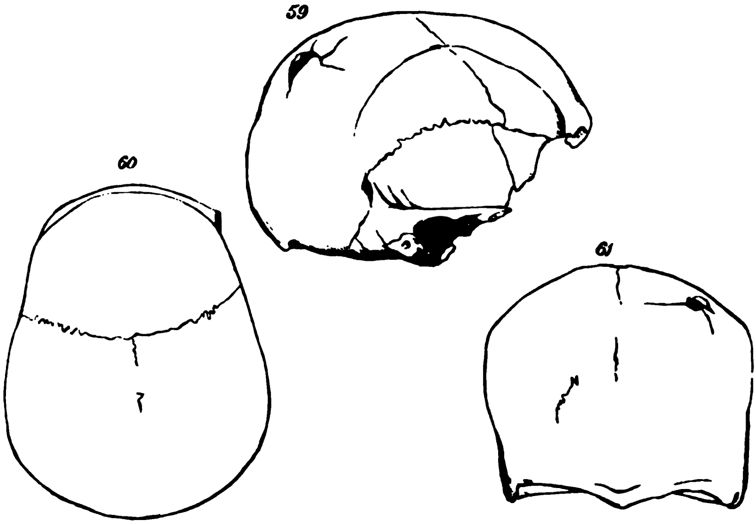
The only specimen of human remains from this locality is a nearly entire *calvaria*, wanting the whole of the face below the superciliary border.

In the middle of the left parietal bone is a small irregular opening, with short radiating lines of fracture proceeding from it; but this appears to have been recently caused, and from the inside.

The bone generally is of a brown colour, and, as regards firmness, in a natural condition; and it does not adhere to the tongue. Judging from its aspect alone, it would not appear to be of any very great antiquity; but as it has lain in a dry soil, and sheltered from rain or moisture, this appearance may be deceptive.

Its dimensions are given in Table I. (*supra*), from which it will be seen that the cephalic or latitudinal index is ·770, and the altitudinal ·702. It belongs, therefore, to the category of subbrachy-cephalic skulls of Thurnam and Professor Huxley.

In the side view (*norma lateralis*—Plate 7, Fig. 59), it so closely resembles, except in one respect, that described and figured by Professor Huxley (*loc. cit.* p. 125, Figs. 60, 61) from the bed of the Nore, at Borris, in Ireland, that we can scarcely refuse to recognize a common character between them, which, since in the present case it cannot be looked upon as denoting a mere family relationship, may reasonably be regarded as



FIGS. 59, 60, 61.—Skull from Cave at Cefn, St. Asaph.

indicative of some affinity of race. The chief difference observable in this view of the two skulls is the greater development of the frontal sinuses in the Borris *calvaria*. The occipital view (*norma occipitalis*, Fig. 8) is also very similar, except that in the Borris skull the greatest width appears to be in the temporal, and in the other the parietal region. In the Borris skull, also, there is a shallow groove in the course of the sagittal suture, which does not exist in that from St. Asaph.

The Borris skull is said to be of the extraordinary length of 8 inches; and this may account for the much lower cephalic index of the skull, whose absolute width in reality somewhat exceeds the Cefn

specimen (5″·9 and 5″·7), whilst the altitudinal as compared with the latitudinal is but very little greater than it would be were the skulls reduced to the same breadth. They may both, therefore, be regarded as "low," or, as this class of skull might be termed, in the euphonious language of craniologists, "tapinocephalic." One great peculiarity of the Cefn *cranium* (which exists also, but apparently not to quite so great a degree, in the other) is the absolute horizontality of the plane of the subinial portion of the occipital bone. And it is to this flattening that the comparative lowness may perhaps be chiefly attributed.

The sutures, where visible, appear to be open. The mastoid processes and all other muscular impressions are strongly marked.

A third skull of very similar character, except that it is not so much depressed, has come under my observation. It was discovered in a submarine or, rather, subterranean peat-bed or ancient forest, 30 feet below the sea-level, at Sennen, near the Land's End, in Cornwall; and a brief notice and outline figure of it will be found in the "Natural History Review" for 1861.[1] The Sennen skull has the same elongated form; but it is higher than either the Cefn, St. Asaph, or Borris crania, having an altitudinal index of ·730.

On the whole, these three skulls (*i.e.* those from Borris, Sennen, and St. Asaph) would appear to have a common character, and to be of a different type from either the Perthi-Chwareu or the Mewslade form.

As a rule it may, I think, be stated that in all brachy-cephalic skulls the breadth exceeds the height, whilst the reverse is the case in the dolicho-cephalic. Individual exceptions are of course not unfrequently met with, more especially among very mixed races, such as the modern English; but I am myself acquainted with only two dolicho-cephalic *races*, properly so termed, in which the rule does not hold good. These are the Tasmanian (not Australian) and the Bushman.

Any exceptions, therefore, to either rule among ancient and, consequently, less mixed races are worthy of being noted.

As regards modern brachy-cephalic skulls the law holds almost universally, the only marked exception, except in an individual here and there, being in two Karén skulls, in which, although both decidedly brachy-cephalic, the respective indices stand as ·848 to ·924, and as ·790 to ·842.

Among priscan brachy-cephalic skulls the most remarkable and important exceptions I have met with occur among the neolithic crania in the Copenhagen Museum, more than half of which are brachy-

[1] Vol. i. p. 174, pl. v.

cephalic, and most of the others nearly so, the mean cephalic index of 21 skulls being ·790, whilst the mean altitudinal is as high as ·810. In fact, out of 12 skulls whose indices vary from ·795 to ·838, no fewer than 10 have the latitudinal index less than the altitudinal.

The exceptions to the rule as applied to dolicho-cephalic skulls also appear to be far more common among the ancient than among the modern, excepting the two races I have above referred to.

In a long list of ancient and priscan skulls, I find the following having the tapino-cephalic character :—

	L. Ind.	Alt. Ind.
1. From the Thames alluvium at Old Ford	·792	·753
2. From the same deposit at East Ham.	·774	·690
3. From the same deposit at Battersea	763	·745
4. From the same deposit at London Bridge	·762	·611
5. From tumulus at Stanshope	·763	·684
6. A Guanche skull	·775	·737
7. A Guanche skull	·763	·684
8. Cefn, St. Asaph's	·770	·702

The number is but small, it must be confessed, and perhaps hardly sufficient to do more than prove the rule; but still I think it will be found worth inquiry whether a departure from the rule in question was more frequent among the unmixed or little-mixed races of ancient times than it is amongst similarly unmixed races of the present day; and whether consequently its infraction in a considerable number of instances may or may not be indicative of a lower type, as which we are accustomed to regard the Tasmanian and Bushman races.

General Conclusions as to Human Remains.

The human remains in the caves of Perthi-Chwareu and Cefn, and in the cairn near the latter place, imply that the men to which they belonged were a short race, the tallest being about 5 feet 6 inches, and the shortest 4 feet 10 inches.[1] Their skulls are orthognathic,[2] or not

[1] The stature is obtained, according to Prof. Humphry's method, from the length of the femur, which is 27·5 of stature taken as 100.

[2] Ορθος straight, γναθος jaw, with profile vertical, as opposed to προγναθος, with projecting jaws, or "snouty."

presenting a lower jaw advancing beyond the vertical line dropped from the forehead; in shape ortho-cephalic, or subbrachy-cephalous, and of fair average capacity. The face was oval and the cheek-bones were not prominent. Some of the individuals were characterised by the peculiar flattening of shin (platycnemism), which probably stood in relation to the free action of the foot that was not impeded by the use of a rigid sole or sandal. This character, however, is neither peculiar to race, nor to be viewed as a tendency towards the simian type of leg. These conclusions, which Professor Busk has arrived at from the examination of the remains which were submitted to him, have been fully borne out by the numerous skeletons which have been subsequently discovered, both in the sepulchral caves at Rhosdigre and in a second chamber in the cairn of Tyddyn Bleiddyn near Cefn.

CHAPTER VI.

THE RANGE OF NEOLITHIC DOLICHO-CEPHALI AND BRACHY-CEPHALI.

Relation of Human Remains to those found in Tumuli in Britain.—The Dolicho-cephali and Brachy-cephali.—Their Range in Britain and Ireland—in France.—The Caverne de l'Homme Mort.—The Sepulchral Cave of Orrouy.—The Tumuli.—In Belgium.—The Sepulchral Caves of Chauvaux and Sclaigneaux.—The Dolicho-cephali of the Iberian Peninsula—Gibraltar—Spain.—Cueva de los Murcielagos.—The Woman's Cave near Alhama in Granada.—The Guanches of the Canary Isles.—Iberic Dolicho-cephali of the same race as those of Britain, France, and Belgium—Cognate or Identical with the Basque Race.—Evidence of History as to the Peoples of Gaul and Spain.—The Basque Populations the Oldest.—The Population of Britain.—Basque characters in Present Population of Britain and France.—Whence came the Basques?—The Celtic and Belgic Brachy-cephali.—The Ancient German Race.—General Conclusions.

The Relation of the Human Remains to those found in British Tumuli.

Before we examine the relation of this ancient neolithic race of men to those who have left their remains in tumuli and caves in other regions, it is necessary to define the cranial terminology, as adopted by Professors Busk, Huxley, Dr. Thurnam, and other high authorities.

into the broad, the oval skulls being the intermediate forms; and this would naturally result from the intermingling of the blood of the two races. There may, however, have been a tendency towards ortho-cephalism in the dolicho-cephali, without any admixture of foreign blood, since absolute unity of form could not be expected.

The skull of the primary interment in the barrow of Winterbourne Stoke is taken by Dr. Thurnam as typical of the dolicho-cephalic class. "The greatest length is 7·3 inches (the glabello-inial diameter 7·1 inches); the greatest breadth is 5·5 inches, being in the proportion of 75 to the length taken as 100. The forehead is narrow and receding, and moderately high in the coronal region, behind which is a trace of transverse depression. The parietal tubers are somewhat full, and add materially to the breadth of this otherwise narrow skull. The posterior borders of the parietals are prolonged backwards, to join a complex chain of Wormian bones in the line of the lambdoid suture. The superior scale of the occiput is full, rounded, and prominent; the inion more pronounced than usual in this class of dolicho-cephalic skulls. The superciliaries are well marked, the orbits rather small and long; the nasals prominent, the facial bones short and small; the molars flat and almost vertical; the alveolars short, but rather projecting. The mandible is comparatively small, but angular; the chin square, narrow, and prominent."[1]

Dolicho-cephalic skulls in general (and in part ortho-cephalic) are possessed, according to Dr. Thurnam, of the following characters (Vol. iii. p. 69):—"The supra-ciliary ridges are less strongly marked than in the brachy-cephalic. There is none of the prognathism, exaggerated

[1] "Anthrop. Mem." vol. i. p. 144.

malar breadth or great width of the nasal openings, which give such an air of savageness and ferocity to the New Caledonians and Caroline Islanders; but the very reverse of all these. They are indeed more orthognathic even than many Europeans, and the facial characters generally are mild, and without exaggerated development in any one direction." Their faces are oval. The upper jaw is small, and the sockets of the incisors and canine almost vertical. The supra-occipital region is full and rounded, and there is a post-coronal annular depression on the skull, termed by Dr. Gosse "tête annulaire." The length is mainly due to the development of the occiput, a condition that is termed by M. Broca "dolicho-cephalie occipitale," as distinguished from the "dolicho-cephalie frontale" of other races. The teeth are worn flat. The bones associated with the skulls of this character show that the stature of the race was short, 5 feet 5 inches being the average height.

In the brachy-cephalic, or broad skulls, on the other hand, the supraciliary ridges are more strongly marked than in the preceding group; the cheek-bones are high and broad, the sockets for the front teeth are oblique, and the mouth projects beyond the vertical dropped from the forehead, presenting the character of prognathism. The face, instead of being oval, is angular or lozenge-shaped. On the back of the head the occipital tuberosity, or probole, is the most prominent feature, and there is also generally an occipital flattening, which may have been caused by the use of an unyielding cradle-board in infancy. The entire maxillary apparatus is so largely developed, that the term "macrognathic," introduced by Professor Huxley, is particularly applicable to them. The "type mongoloide" of Dr. Pruner-Bey

is closely allied to, if not identical with, this form of skull.

The stature of the British brachy-cephali is much greater than that of the dolicho-cephali, the average for the adult male being 5 feet 8·4 inches, according to Dr. Thurnam.

The human remains from the caves and chambered-tombs of Denbighshire belong to the first of these divisions, in the possession of every one of the characters assigned to it by Dr. Thurnam, although the crania belong to the ortho-cephalous portion of the series, that is, tending towards broad-headedness. It may therefore be inferred that they belong to the same race as the neolithic raisers of the long-barrows, a race which we shall presently see to be identical with the ancient Iberians and modern Basques.

The Range of the Dolicho-cephali in Britain and Ireland.

The same class of human remains has been obtained from caves in other districts in Great Britain. In the Oxford Museum a human skull, from the cave of Llandebie, possesses cephalic index of ·72; while a second, from the cave of Uphill in Somersetshire, explored by Mr. James Parker in 1863, measures ·723. (See p. 197.) The latter was associated with rude pottery, charcoal, and the remains of the following amimals: the wild-cat, dog, fox, badger, pig, stag, *Bos longifrons*, goat, and water-rat. Most of the remains belong to young individuals, and some have been gnawed by dogs, wolves, or foxes.

In Yorkshire a human femur presenting an enormous development of the linea aspera, which implies the possession of the platycnemic character, has been met with in a cave in King's Scar, near Settle (see p. 113), and fragments of a long skull are preserved in the Museum at Leeds from that of Dowkerbottom.

Professor Turner has described[1] the remains found in a cave in the Old Red sandstone on the shore of the bay of Oban in 1869 by Mr. Mackay. There were two human skeletons, along with the broken and burnt bones of the roe and stag, limpet-shells, flint nodules, and flint flakes. One of the leg-bones is platycnemic, and the fragments of skull may probably be referred to the dolicho-cephalic type.

The same type of skull has also been obtained by the Rev. Canon Greenwell, from the neolithic tumuli of Yorkshire, along with the same group of animals as in the caves at Perthi-Chwareu, the *Bos longifrons*, goat, horse, dog, and stag; and Professor Rolleston, F.R.S., informs me that some of the associated human leg-bones are platycnemic. It is also recognized by Professor Huxley as identical with his river-bed type of skulls from alluvial deposits near Muskham in the valley of the Trent, Ledbury Hall in the valley of the Dove, and in Ireland from the bed of the Nore in Queen's County, and from that of the river Blackwater. To it also Professor Huxley refers[2] five or six out of the seven skulls obtained by Mr. Laing from the stone cists in the burial mound at Keiss in Caithness, and associated with rude weapons and implements of bone and stone. They

[1] Brit. Assoc. Report, 1871, p. 160, "On Human and Animal Bones and Flints, from a Cave at Oban, Argyleshire," by Prof. Turner.

[2] Huxley and Laing, "Prehistoric Remains of Caithness," p. 119 *et seq.*

probably belonged to the inhabitants of the neighbouring burgh, or circular stone dwelling, in and around which were the broken bones of the following animal remains: the *Bos longifrons*, goat, stag, hog, horse, dog, fox, grampus or small whale, dolphin or some other small cetacean, great auk (*Alca impennis*, now extinct in Europe), lesser auk, cormorant, shag, solan goose, cod, lobster, and shell-fish. A lower jaw also of a child, broken after the same manner as other refuse bones, is considered by Professor Owen and Mr. Laing to prove that human flesh was sometimes used for food. The reindeer was living in the district at this time, since its remains have been identified by Dr. Campbell from the Harbour mound, one of the many refuse-heaps in the neighbourhood.

The same kind of skull is also described by Professor Wilson under the name of "boat-shaped" or "kumbecephalic," from the ancient stone chambers and tumuli of Scotland.[1]

In the Table on the next page, showing the relative size and shape of the more important long skulls of Britain and Ireland, it will be seen that the extreme long-headedness of those from the long barrows is not possessed by those either of the caves and tombs of Denbighshire or of the river-bed type of Huxley, represented by the skulls from Muskham, Ledbury, Blackwater (Ireland), and Keiss.

The greater breadth of the skulls from the caves and tombs of Denbighshire, as compared with those of the typical long skulls from the long barrows, may possibly be due to a mixture with the broad-headed race. In that case, however, none of the tallness, or prognathism,

[1] "Prehistoric Annals of Scotland."

of the latter has been handed down. It is most probably a mere variation within the limits of one race, and is unaccompanied by the fusion of dolicho-cephalic with brachy-cephalic characters, such as M. Broca and Dr. Thurnam have observed in the skulls from tombs and caves in France.

SKULLS.	Length.	Breadth.	Height.	Circumference.	Latitud. or Ceph. Index.	Alt. Index.
Mean of 48 males, Brit., Thurnam, long barrows	7·7	5·5	5·62	21·3	·715	·730
Mean of 19 females, Brit., Thurnam long barrows	7·45	5·3	5·3	20·6	·710	·730
Mean of 10 skulls, Perthi-Chwareu Cave	7·07	5·5	5·6	20·0	·765	—
Skull from Llandebie Cave	7·3	5·3	—	—	·720	—
,, Uphill	7·36	5·43	—	—	·723	—
Mean of 6 skulls from Keiss. (Huxley)	7·22	5·45	5·19	—	·755	·716
Skull from Muskham ,,	7·0	5·4	—	—	·770	—
,, Ledbury Hall ,,	7·15	5·5	—	—	·770	—
,, Blackwater, Ireland ,,	7·2	5·65	—	—	·780	—

From the examples given in the preceding pages it is evident that, in ancient times, long-headed men of small stature inhabited the whole of Britain and Ireland, burying their dead in caves, but more generally in chambered tombs. They were farmers and shepherds, and in this country in the neolithic stage of culture. In the solitary case offered by the Harbour mound at Keiss they were cannibals.[1]

The Range of the Brachy-cephali.

No human remains of the brachy-cephalic, or broad type, as defined by Dr. Thurnam have been obtained

[1] The evidence of cannibalism in the contents of the tumuli seems to me to be doubtful.

from the caves in Britain. The evidence, however, is decisive that, in the Bronze age, a tall, round-headed, rugged-featured race occupied all those parts of Britain and Ireland that were worth conquering, and drove away to the west or absorbed the smaller neolithic inhabitants. And the identity of their skull-form, in the series of interments in the round and bowl-shaped barrows, extending from the Bronze age down to the date of the Roman occupation of Britain, shows that, both in the North and the South, this large-sized coarse-featured people was in possession at the time of the Roman conquest.

The size and shape of the typical broad crania may be gathered from the first two columns of the following Table, which is an abstract of those published by Dr. Thurnam in "Crania Britannica," and the "Memoirs of the Anthropological Society."

The Range of the Dolicho-cephali and Brachy-cephali in France in the Neolithic Age.—The Caverne de l'Homme Mort.

The researches of M. Broca and Dr. Thurnam into the caves and tombs of France prove that the small dolicho-cephali and the tall brachy-cephali lived in that country in the neolithic age. We are indebted to the former for a most important account of the Caverne de l'Homme Mort, which reproduces all the essential points which we have observed in the sepulchral caves of Denbighshire.

The Caverne de l'Homme Mort[1] is situated in a lonely ravine that penetrates the wild limestone plateau, in

[1] Prehistoric Congress, Brussels Volume, 1872, p. 182.

Measurements of British Brachy-cephali, and Gaulish and Belgic Brachy-cephali and Dolicho-cephali.

Skull.	Date.*	Length.	Breadth.	Height.	Circumference.	Latitudinal or Cephalic index.	Altitudinal index.
TYPICAL BROAD SKULLS.—BRITAIN.							
Mean of 56 males, Brit. Round Barrows	N. B. I.	7·28	5·9	5·6	21·1	·81	·77
Mean of 14 females, Brit. Round Barrows		6·9	5·6	5·3	20·	·81	·77
LONG AND SHORT SKULLS.—FRANCE.							
Tumulus, Noyelles-sur-mer-Somme	N.	6·9	5·6p	5·5	20·3	·81	·79
"Grotto," Nogent les Vièrges, Oise	N.	7·2	5·8p	5·5	21·	·80	·76
,, ,, ,, ,,		7·3	5·2p	5·2	20·1	·71	·71
,, ,, ,, ,,		7·1	5·7p	5·2	20·8	·80	·73
,, ,, ,, ,,		6·9	5·9p	5·5	20·9	·85	·79
,, ,, ,, ,,		7·3	5·4p	5·5	20·6	·74	·75
,, ,, ,, ,,		7·4	5·2p	5·6	20·8	·70	·75
Dolmen Du Val, Senlis, Oise	N.	6·6	5·6p	5·4	19·7	·84	·81
,, ,, ,, ,,		7·1	5·5p	5·6	20·2	·77	·78
,, ,, ,, ,,		7·2	5·5	5·8	20·8	·76	·80
,, ,, ,, ,,		7·2	5·8	—	—	·80	—
,, Chamant ,, ,,	N.	7·4	5·3	—	—	·71	—
,, ,, ,, ,,		7·1	5·5	—	—	·78	—
,, ,, ,, ,,		7·4	5·5	5·4	—	·74	·72
Cave, Orrouy, Oise	N.B.(?)	7·4	5·8	5·3	21·2	·78	·72
,, ,, ,,		7·1	5·8p	5·3	—	·77	·74
,, ,, ,,		7·2	5·4p	5·7	20·1	·75	·81
,, ,, ,,		7·1	5·9p	5·6	20·7	·83	·78
,, ,, ,,		6·7	5·5p	5·4	19·2	·82	·80
,, ,, ,,		6·6	5·6p	5·5	19·9	·85	·83
,, ,, ,,		7·2	5·9	5·4	20·9	·81	·75
,, ,, ,,		6·8	5·75	5·1	20·4	·84	·75
,, ,, ,,	N.	7·4	5·8	5·7	—	·78	·77
,, ,, ,,		7·2	5·9	—	20·8	·81	—
Lombrive, Ariège	N.	6·7	5·5	5·5	19·2	·82	·82
Dolmen, Meudon, Seine et Oise		7·	5·95p	5·9	20·7	·85	·84
,, ,, ,, ,,		7·2	5·7	5·5	20·8	·79	·76
Lozerres		7·3	5·8p	5·7	21·	·79	·78
Tomb, Maintenon; Eure et Loire		7·25	5·5	—	20·3	·75	—
,, ,, ,, ,,		7·7	5·5	—	20·8	·71	—
Tumulus, Bougon, Deux Sèvres		6·7	5·4p	—	20·	·80	—
Dolmen, Meloisy, Côte d'Or	N.	7·3	5·5	—	20·9	·75	—
Avignon(?), Vaucleuse		6·9	5·8	—	20·7	·84	—
,, ,,		7·8	5·5p	—	21·8	·70	—
Genthod, Geneva	I.	7·4	5·6p	5·5	21·1	·75	·74
,, ,,		6·9	5·6p	5·4	20·5	·81	·78
Mean		7·1	5·6	5·5	20·5	·78	·77
Judge's Cave, Gibraltar (Busk)	(?)	6·9	5·4	5·4	19·5	·792	—
Chauvaux Cave (Virchow)	N	7·35	5·3	5·3	—	71·8	1·8
Sclaigneaux Cave. Skull 1. (Arnould)	N	7·35	6·5	5·4	—	81·1	73·7
,, ,, ,, 2.		7·25	6·25	5·25	—	81·6	70·6
,, ,, ,, 3.		6·9	5·75	—	—	—	—
,, ,, ,, 4.		6·95	—	—	—	—	—

* N, Neolithic; B, Bronze; I, Iron.

the south-west of the department of Lozère, near the hamlet of Vialle, in the commune of St. Pierre des Tripiés. It was discovered by the peasants, and its contents were partially disturbed by their search after hidden treasure before it was explored by Dr. Prunières. In front of the cave was a platform, composed of earth mingled with fragments of charcoal, forming a layer about forty centimetres thick, in which were the stones of seven hearths, flint-flakes and scrapers, lance-heads, broken bones of the hare, fallow-deer, roe, pig (or wild-boar). All the flints were worked, and one lance-head had been chipped out of the stump of a celt and presented portions of the polished surface, thus fixing the neolithic age of the accumulation. Coarse pottery was also met with.

The bones of the hare were very abundant, and proved that there was no prejudice against the use of its flesh. In the caves of Perthi-Chwareu we have also seen that this was the case.

The refuse-heaps ceased abruptly at the entrance of the cave, at a point where the traces of a wall, composed of large stones, was visible. Immediately behind this were human bones, in a thick layer of dry sand, scattered about in the wildest confusion, which was probably the result of successive interments, as well as of subsequent disturbance by burrowing animals and treasure-seekers. Two bone-points and a flint arrow-head were the only implements discovered within the sepulchral chamber.

Two small human bones, bearing undoubted marks of having been burnt, were discovered in the refuse-heap; but they do not, as M. Broca justly observes, imply the practice of cannibalism, since they may have fallen out

of the burial-place, and subsequently have come into contact with the fire on one of the hearths.

It is impossible to estimate the number of interments in this cave. Exclusive of the many skulls which have been destroyed or lost, M. Prunières obtained nineteen very nearly perfect, which are described by M. Broca as seven male, six female, three of uncertain sex, and three children. They are remarkable for the softness of their contours, the delicacy of their features, and the orthognathism of their faces. The forehead is wide and high, and the vertex and the occipital region of the skull well rounded. The cephalic index varies between ·680 and ·78, the mean of the whole series being ·732.

M. Broca remarks, that these crania contrast strongly with those of the present broad-headed inhabitants of the district, and that they differ from those found in the dolmens by M. Prunières in their greater length, in the smallness of their features, and the weakness of their muscular impressions. The study of the bones of the skeleton confirms these differences. The men who buried their dead in the Caverne de l'Homme Mort were smaller than the dolmen builders, their bones were more slender, and they were altogether a less muscular race. They are considered by M. Broca to represent the neolithic aborigines; and if his description and measurements be compared with those of the dolicho-cephali of Britain, given by Dr. Thurnam (p. 191 *et seq.*), it will be seen that they are identical with the latter, which is the oldest race yet known to have occupied Great Britain since the close of the pleistocene period.

At a little distance from the sepulchral cave, and in the same ravine, M. Broca explored a large cavern, which had been occupied, probably by the same people, since

the same kind of instruments were discovered as in the refuse-heap. So that we have here, side by side, the abode and the sepulchre of the same ancient tribe.

The Sepulchral Cave of Orrouy.

The sepulchral cave of Orrouy (Oise) described by M. Broca, in which the remains of about fifty individuals were interred, furnished both types of skull, united, according to Dr. Thurnam and M. Broca,[1] by a series of intermediate forms, that prove a fusion of blood between the broad- and the long-headed peoples. On referring to the preceding Table (p. 199) it will be seen that the cephalic index varies from ·75 to ·88. Eight out of the series of twenty-one skulls united the characteristic dolicho-cephalous fore-head with the brachy-cephalous middle and hind-head. "We have here," writes Dr. Thurnam, "a veritable hybrid form of cranium, resulting from the mixture or crossing, under certain circumstances unknown to us, of a dolicho-cephalous with a brachy-cephalous race."

". . . In the Orrouy skulls of hybrid form, two encephalic growth-tendencies appear to me distinguishable; one, the longitudinal or fronto-occipital; the other a transverse, or bi-parietal and temporal one. Now the remarkable supramastoid depressions, visible in the hind-head of these skulls, seem to be well explained by the idea of an intersection or crossing of these two tendencies in the brain-growth; corresponding, as they must have done, to the angles formed by the posterior surfaces of the middle, the lower surfaces of the posterior

[1] Bull. Soc. Anthrop. iv.

and temporal lobes of the cerebrum, and the upper surface of the cerebellum."[1]

In eight out of thirty-four humeri the fossa of the olecranon is perforated.

The human remains occurred in the same confusion as at Perthi-Chwareu, and were associated with fragments of coarse pottery, flint flakes, and bones of ruminants. The occurrence of polished stone celts indicates the neolithic age of the interment.

Skulls from French Tumuli.

Both long and broad skulls also occur in the chambered tombs of France, although the latter by far predominate. Those from the Long Barrow at Chamant are dolicho-cephalic and ortho-cephalic, with cephalic index ranging from ·71 to ·78 (Broca), and other similar cases are quoted by Dr. Thurnam from Noyelle-sur-Mer, Fontenay, and other tumuli. In the large sepulchral chamber at Meudon, that contained 200 skeletons, the majority of the skulls were brachy-cephalic, although twenty of them were of the ortho-cephalic type. This mixture may be accounted for, most probably, by the two races, which are clearly defined from each other in Britain, being intermingled in France.

Dr. Thurnam, summing up the whole evidence as regards the distribution of races in the tombs of Gaul, concludes that the two races came into contact in Gaul at an earlier period in the neolithic age than in Britain. And this must necessarily have been the case from the geographical position of our island, which could only be invaded, in those times, by the races in possession of the

[1] Anthrop. Mem. i. 490.

contiguous mainland of France and Belgium. Both these regions must have been conquered before an invasion could have taken place.

The Dolicho-cephali of the Iberian Peninsula, Gibraltar.

The researches carried on from 1863 to 1868, by Captain Brome, aided by Dr. Falconer and Professor Busk,[1] into the caves of Gibraltar, have resulted in the proof that, in the neolithic age, that barren rock was inhabited by a race of men identical with that which is found in the long barrows and caves of Great Britain.

The enlargement of the military prison on the top of Windmill Hill revealed the existence of a deep fissure, containing dark earth, mingled with charcoal and broken bones, which led into a series of chambers. The upper of these is described by Captain Brome as being completely choked up to the roof with earth, charcoal, and decomposed bones of mammals, birds, and fishes, flint flakes, and pottery. Below were two floors of stalagmite, filled with loose stones and earth, through which a shaft penetrated into a fissure at a lower level, leading into a lower chamber that had a free communication with the surface, since the current of air was so strong as to extinguish the lamps. In this also human remains and works of art were met with. The passages were very complicated, and in some of them a red breccia contained the remains of the pleistocene mammals, the spotted hyæna, the *Rhinoceros hemitœchus*, and others. This series of passages and chambers is described by

[1] Prehistoric Congress, Norwich Volume, 1869.

Captain Brome and Professor Busk as "Genista Cave No. 1."

A second, or "Genista, No. 2," was discovered by Captain Brome opening on the surface near the West Cliff, with its floor covered with stalagmite, under which was the same class of remains as that above mentioned. Subsequently a third and fourth, "Genista, 3 and 4," were explored with the same results, of which the latter, opening on the face of a vertical cliff 40 feet below the summit, from its difficulty of access must have been used as a place of refuge rather than of habitation or burial. With this exception, the whole group of Genista Caves contained human bones, resting in the greatest confusion, and proving that since the bodies had been interred the contents had been disturbed, either by the burrowing of animals or by the action of water, pools of which were present in some of the chambers. Evidence of the former presence of water was to be seen in the sheets of stalagmite on most of the floors. The same confusion would result, as is suggested by Professor Busk, by interments at successive times. The intimate association of the fractured bones of the animals, and the charcoal, broken pottery, and other traces of occupation, with the human bones, may be accounted for in the same manner as the similar mixture of remains in the caves of Denbighshire. If the caves had been inhabited at one time, and subsequently set apart for burials, the human bones would become intermingled with the accumulation of refuse on the floors by the causes above mentioned.

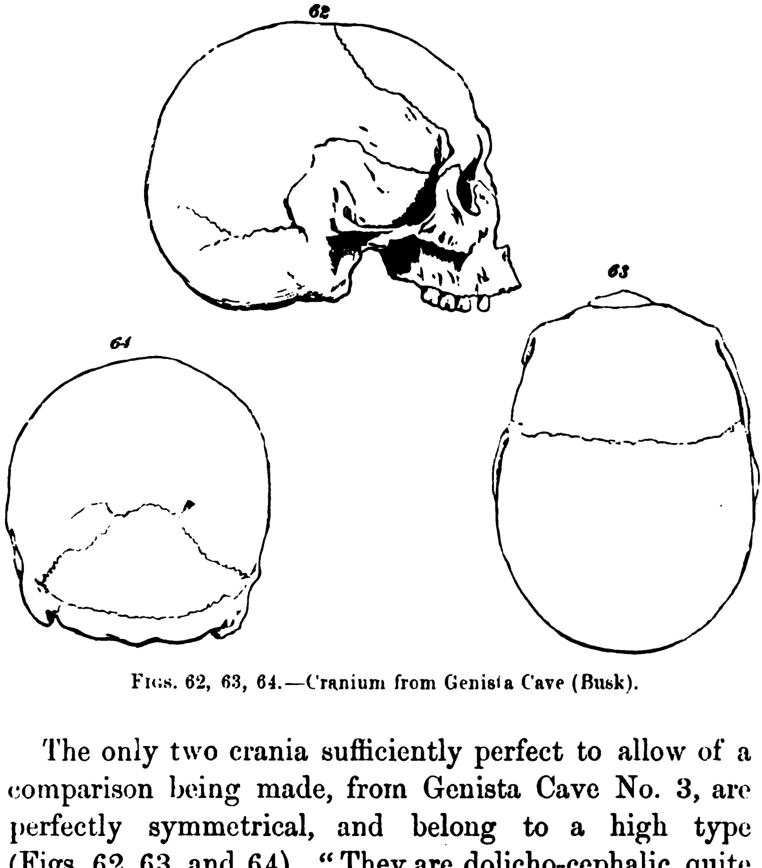
The bones of the animals associated with the human remains belong, according to Professor Busk, to the domestic ox of various sizes, goat, ibex, hog, arvicola,

hare, rabbit, badger, dog, and a species of phocæna, fish, birds, and marine and land molluscs. The pottery is for the most part hand-made, coarse and imperfectly burnt; and the vessels in some cases had singular perforated spouts, similar to those still in use by the Kabyles of Algeria, and some of the Berber tribes. Some of it, however, is of a fine red ware turned in the lathe, and probably introduced at a later period, even, as remarked by Mr. Franks, after the Roman occupation of Spain, to which he refers a bronze fish-hook, the only metallic article found in the group of caves. The implements of bone consist of a needle, and rounded pins and spikes. One cannon-bone of a small ox bears marks of sharp cuts with an edge of metal, inflicted probably, as Professor Busk suggests, "in an attempt to hamstring the animal, as is sometimes done at the present day in the Spanish bull-ring." It may possibly be more modern than the stone implements found in the same cave.

The associated stone articles are celts of polished greenstone, similar to that found in the neolithic cave at Perthi-Chwareu (Fig. 38), flakes, a greenstone chisel, querns and rubbing-stones, a whetstone perforated for suspension, and a fragment of an armlet made of alabaster. A small lump of coarse plumbago may have been used for personal ornament.

The human remains examined by Professor Busk belonged to a large number of individuals of all ages, and are for the most part in a fragmentary condition. Some of the thigh-bones are carinate, and remarkable for the enormous development of the *linea aspera* and the thickness of their walls (Fig. 57), the medullary cavity being reduced to a small size, as in those figured from the tumulus at Cefn. Some of the

tibiæ are platycnemic, presenting the peculiar lateral flattening which first attracted the attention of Dr. Falconer and Professor Busk (Figs. 49, 50, and 51), but which M. Broca has since determined in the tumuli and caves of France, and I have discovered in those of Denbighshire (p. 177).



FIGS. 62, 63, 64.—Cranium from Genista Cave (Busk).

The only two crania sufficiently perfect to allow of a comparison being made, from Genista Cave No. 3, are perfectly symmetrical, and belong to a high type (Figs. 62, 63, and 64). "They are dolicho-cephalic, quite orthognathous, and wholly aphanozygous. In one the frontal sinuses are considerably more developed than they are in the other, but in neither is there any thick-

ening of the supra-orbital border" (Busk). The teeth are worn flat. They both belonged to men in the prime of life. A third skull, from Genista Cave No. 1, belongs to the same type. The measurements of the two most perfect skulls are given in the same table as those from North Wales (p. 171).

Gibraltar has also been occupied in ancient times by broad-headed men, similar, in M. Broca's opinion, to those interred in the cave of Orrouy. In 1864 human bones, together with a skull (for measurements see p. 199), were dug out of the Judge's Cave by Sir James Cochrane. The tibiæ are platycnemic, and the skull is described by Professor Busk as being "perfectly symmetrical, brachy-cephalic, slightly prognathous, but with vertical teeth, aphanozygous. The forehead is well arched, and the supra-orbital border slightly elevated, the orbits being square, and the nasal opening elongated and pyriform." The cephalic index is ·792. The age of these skeletons is uncertain.

Spain.—Cueva de los Murciélagos.

Professor Busk [1] calls attention to the fact, that a long skull similar to that from Gibraltar has been found in Spain, in an ancient copper-mine of the Asturias, together with hammers made of antler, and that it bears "the closest possible resemblance" to the Basque skulls, described by M. Broca, from Guipuscoa on the Spanish and St. Jean de Luz on the French side of the Pyrenees. He points out, also, the resemblance which exists between the crania figured by Don Gongora y Martinez, from the caverns and dolmens of Andalusia and those under

[1] Prehistoric Congress, Norwich Volume, 1869.

consideration; finally arriving at the conclusion that "a pretty uniform priscan race at one time pervaded the peninsula from one end to the other, and that this race is at the present day represented by, at any rate, a part of the population now inhabiting the Basque provinces."

In the work of Don Manuel Gongora y Martinez[1] referred to, there is a most interesting account of the prehistoric antiquities of Andalusia. Several interments are described in the Cueva de los Murciélagos, a cave running into the limestone rock, out of which the grand scenery of the southern part of the Sierra Nevada has been, to a great extent, carved. In one spot, a group of three skeletons was met with, one of which was adorned with a plain coronet of gold, and clad in a tunic made of esparto-grass, finely plaited, so as to form a pattern which resembles some of the designs on gold ornaments from Etruscan tombs. At a spot further within, a second group of twelve skeletons lay in a semicircle, around one considered by Don Manuel to have belonged to a woman, covered with a tunic of skin, and wearing a necklace of esparto-grass, a marine shell pierced for suspension, the carved tusk of a wild boar, and earrings of black stone. There were other articles of plaited esparto-grass, such as baskets and sandals; flint flakes, pieces of a white marble armlet, polished axes of the type of fig. 38, bone awls, and a wooden spoon, together with pottery of the same type as that from Gibraltar, fragments of charcoal, and bones of animals.

Although, in this cave, there were no traces of metal, except gold, in a second, in the same neighbourhood,

[1] Don Manuel Gongora y Martinez, "Antiguedades Prehistoricas de Andalucia." Madrid, 1868. 8vo.

similar interments were met with in association with copper (bronze) implements, and with pottery of the same kind.

These interments in caves are of the same order as those from Gibraltar; and since the skulls agree with those from the latter, there can be little doubt but that, in the neolithic age, the long-headed small race under discussion had possession of the southern provinces.

The Woman's Cave, near Alhama.

This conclusion derives additional support from the discoveries subsequently made by Mr. McPherson[1] in the Woman's Cave, near Alhama, in Grenada, of implements of bone, flint, and greenstone of the neolithic age, mingled with charcoal, pottery, and human skeletons of the same type as those from Gibraltar. The human skull, figured by Mr. McPherson, is dolichocephalic, and the thigh-bone is remarkable for the extreme development of the *linea aspera*, which assumes the form of a stout ridge sweeping from one extremity of the shaft to the other.

This long-headed race, burying their dead in caves, also erected dolmens in Andalusia. In the dolmen of De los Eriales[2] human remains were discovered along with bronze (copper?) lance-heads, and pottery of the same sort as that of the caves. It is, therefore, evident that the practice of burial in caves, and of erecting dolmens, was carried on by the same people in Britain, in France, and in Spain.

[1] "The Woman's Cave," 4to. Parts I. and II. 1870-1. Cadiz, Federico Joly y Velasco.

[2] Don Manuel Gongora y Martinez, *op. cit.*

The Guanches of the Canary Isles.

The Guanches,[1] the ancient inhabitants of the Canary Isles, are considered by Berthollet, Glas, and other high authorities, to be allied to the Berbers of North Africa in language. At the time of their discovery and conquest by the Spaniards, they are described by Miss Haigh as being unacquainted with the use of any metal, and as fashioning their weapons out of a black, hard stone. The Guanches of Teneriffe lived principally in caves, preferring for their winter residence those near the coast, and "in the summer those in the higher parts in the interior of the island, whence they could enjoy the fresh air of the hills." Some of these caves have been excavated by the hand of man, and are divided into square chambers, containing rock-hewn benches, "and deep niches made to contain vessels of milk or water." They had also stone houses, thatched with straw or fern. They also buried their dead in sepulchral caves, belonging each to a family or clan, entrances to which are carefully concealed, and are now discovered only by accident. In them the dead were placed either upright, or lying side by side on wooden scaffolds, after having been prepared with salt and butter and thoroughly dried and wrapped in the tanned skins of sheep or goat. In some cases the prepared body was placed in the sitting posture.

They were possessed of a settled government by "Menceys," or chiefs subordinate to one head, and were divided into "nobles and common people, and had a code of punishment for the robber, murderer, and adulterer."

[1] Ethnological Journ. N.S. vii. p. 107.

Their food consisted of sheep and goats, roasted barley ground between two stones, and the fruit of the arbutus, date-palm and fig, as well as fish and rabbits. Their fences were made of reed, their ropes and nets of rushes, and their baskets, mats, and bags, of palm-leaves. They manufactured vessels out of clay or hard wood, needles of fishbones, beads of clay, and they especially excelled in the art of tanning. The civilization of this very interesting people may fairly be taken to be a fragment of that of North Africa and of Europe in the neolithic age, protected by insulation from the influences by which it was swept away from the countries bordering on the shores of the Mediterranean, just as the old Norse customs and legends are preserved by the present inhabitants of Iceland in greater purity than in Norway.

The Berbers are viewed by Professor Busk as of the same non-Aryan stock as the Basque, and the civilization of the Guanches may therefore be taken to represent that of the Iberic peoples of Spain, among whom caves were used in like manner for habitation and burial.

Iberic Dolicho-cephali of the same Race as those of Britain.

If this group of Iberic skulls be compared with those from the caves and tumuli of Great Britain (see Table, p. 197 and that below) it will be seen, that what Professor Busk observes of the ancient population of Spain is equally true of that of our country in the neolithic age. And the identity of form is especially remarkable in the crania from the sepulchral caves at Perthi-Chwareu,

the difference between them being so small as to be of little account:—

	Length.	Brdth.	Height.	Circum-ference.	Ceph. index.
Mean of 10 skulls from Perthi-Chwareu	7·07	5.5	5·6	20·0	·765
Mean of 2 skulls from Genista Cave, No. 3 (Busk)	7·35	5·55	5·9	20·7	·755
Mean of 40 male Basque skulls from Guipuscoa (Thurnam)	7·2	5·5	5·4	—	·760
Mean of 20 female, ditto	6·9	5·3	5·0	—	·760
Mean of 19 skulls, chiefly male . .	7·4	5·6	5·4	—	·760
Mean of 57 female ditto, St. Jean de Luz	7·02	5·6	—	—	·799

The Dolicho-cephali cognate with the Basque.

Nor can the truth of Professor Busk's conclusion, that the group of skulls in question belong to a people akin in blood to the modern Basques, be disputed. We are indebted to M. Broca[1] for the elaborate description of seventy-eight Basque crania from a village cemetery in Guipuscoa, and of fifty-eight from an ossuary at St. Jean de Luz, in which they had been collected in the reign of Francis I., 1532. In both these groups the long and oval types predominated, the broad type being represented by 6·4 (Thurnam) per cent. in the one, and 37·36 per cent. (Broca) in the other; a difference that is doubtless caused by the greater mixture of blood in the south-west of France than in the north-west of Spain, shut off from the broad-headed Gallic tribes by the Pyrenees.[2] Six

[1] Broca, "Bull. Soc. Anthrop." s.s. t. i. p. 470; t. ii. p. 10–30; s.s. t. iii. p. 43–101. The cephalic index in the preceding Table differs slightly from that given by M. Broca. Thurnam, "Anthrop. Mem." iii. p. 64 *et seq.*

[2] These skulls are preserved in the Museum of the Anthropological Society at Paris, where by the kindness of Dr. Broca I was allowed to study them in the autumn of 1873. Some were marked with the "tête annulaire."

skulls, obtained by Professor Virchow from Bilbao, agree in all particulars with those from Guipuscoa. M. Broca has further shown, that this group of Spanish skulls offers all the characters of the black-haired, swarthy, oval-faced, Basque population of the surrounding region, and it therefore follows, that they may be taken as standards of comparison, as typical of the ancient Basque crania, modified, it may be, to some extent, by the infusion of other blood. Their agreement, therefore, with the skulls from Gibraltar implies that the latter are also Basque. And since they agree also with those from the cave of Perthi-Chwareu, as may be seen in the preceding Table, the men who buried their dead in the caves of North Wales in the neolithic age, are proved to belong to the same stock.

The same long-headed, small race also inhabited France, side by side with the broad-headed Gallic tribes; and since to it belong the skeletons in the Cave de l'Homme Mort, which M. Broca refers to the neolithic aborigines, it may reasonably be concluded that in Gaul, as in Britain, it was the older of the two races. The two have also been met with in the caves of Belgium. If we allow that an aboriginal Basque population spread over the whole of Britain, France, and Belgium, and that it was subsequently dispossessed by broad-headed invaders, the two extremes of skull-form and of stature, and of the gradations between them, may be satisfactorily explained. And this view coincides with the well-ascertained facts of history.

Dr. Thurnam was the first to recognize that the long skulls, out of the long barrows of Britain and Ireland, were of the Basque or Iberian type, and Professor Huxley holds that the river-bed skulls belong to the

same race.[1] (Compare Table p. 197 with the preceding.) We have therefore proof, that an Iberian or Basque population spread over the whole of Britain and Ireland in the neolithic age, inhabiting caves, and burying their dead in caves and chambered tombs, just as in the Iberian Peninsula also in the neolithic age.

Dolicho-cephali and Brachy-cephali in Neolithic Caves of Belgium.—Chauvaux.

Both these forms of skull have been met with in Belgium, the one in the famous cave of Chauvaux, the other in that of Sclaigneaux.

The first of these is a rock-shelter passing into a small cave, at the base of the limestone cliff on the Meuse, opposite the little village of Rivière, between Dinant and Namur. It was known to contain human remains in 1837-8, and was partially explored in 1842 by Dr. Spring, who published his account of the discoveries in 1853, and subsequently in 1864 and 1866. Below a thin layer of loam was a floor of stalagmite, concealing a vast number of broken human bones mixed pêle-mêle with those of wild and domestic animals, and associated with charcoal and coarse pottery. Two polished stone celts indicated the neolithic age of the accumulation; one of them resting close to a skull which had been fractured by a blow from a blunt instrument, such as it may have inflicted. The human bones belonged to infants and young adults.

From the fractured and burnt bones of the animals it is clear that they had been accumulated in the cave

[1] Laing and Huxley, "Prehistoric Remains of Caithness."

during the time that it was inhabited by man. Dr. Spring[1] inferred that the broken human bones proved that human beings, as well as the animals, formed the food of the cave-dwellers, and further, since all the human remains belong to young individuals, that the cannibalism was not accidental, or caused by famine, but the result of a deliberate selection.

The facts which induced Dr. Spring to come to this conclusion are interpreted by M. Dupont[2] in a different manner. He holds, that the proportion of young individuals is not greater in Chauvaux than that which he has observed in other sepulchral caves in Belgium, and that there is nothing which forbids the supposition that this also was used as a place of interment. The human bones may have been broken by the foxes and badgers, which are so abundant in the district, and have been mixed, by their continual burrowing, with the remains of the animals in the old refuse-heap accumulated on the floor during the habitation of man. Such a mixture of remains we have already observed in the caves of North Wales and Gibraltar. The recent researches of M. Soreil[3] leave no room for doubting the truth of M. Dupont's interpretation. Two perfect human skeletons were discovered along with flint flakes, pottery, a barbed arrow-head, and many scattered human bones not broken by design, while the long bones of the associated animals bore unmistakeable

[1] Spring, "Bull. Acad. Roy. de Belgique," 1 sér. l. xx. p. 427; 2 sér. l. xviii. p. 479; l. xxii. p. 187.

[2] Dupont, "L'Homme pendant les Âges de la Pierre dans les environs de Dinant sur Meuse," 2d edit. p. 222.

[3] Soreil, "Sur Nouvelle Exploration de la Caverne de Chauvau," Congrès Intern. Anthropologie et d'Archéologie Prehistoriques, p. 381 *et seq.* Bruxelles, 1872.

traces of having been split for the sake of the marrow. On one long bone, for example, of the ox, there were cuts made by a flint implement, as well as the mark of the blow by which it had been split longitudinally; and another ox-bone, and the canine of a boar, bore marks of burning. The bones of the animals were very abundant, and belonged to the following species: beaver, hamster, and other small rodents, hare, badger, fox, boar, stag, roe, ox, and goat. In this case, as in the caves of Perthi-Chwareu, and of l'Homme Mort, the inhabitants had used the hare for food, as well as the other animals, and did not share the prejudice against the use of its flesh for food, which Cæsar remarks of the inhabitants of Britain (Comm. 1, xii.).

The cave must, therefore, be viewed as a place of sepulture for a neolithic people, whose implements abound in the neighbourbood, and not as having been inhabited by a race of cannibals.

The bodies had been interred in the crouching posture, with their thighs bent, their heads resting on their arms, and their faces turned towards the valley. They rested side by side in two small holes, which had been dug in the deposit containing the bones of the animals, and the skeletons were cemented to the rock by stalagmite, and surrounded by large stones. They belonged to individuals far past the prime of life.

Both skulls were dolicho-cephalic, and the most perfect of them is described by Professor Virchow as presenting a parietal flattening, which is probably analogous to the "tête annulaire," so commonly present in the long skulls of the neolithic age. It possesses a cephalic index of ·72 (·718 Virchow). The sutures in both the skulls were very nearly oblite-

rated. The measurements are given in the Table in page 199.

The crania, in all these characters, are to be classified with the long skulls from the caves and chambered tombs of France, Britain, and Spain. They belong to people in the same stage of culture, and practising the same mode of burial in a crouching posture. Chauvaux is the furthest cave to the east on the continent of Europe, in which traces of this long-headed race have been observed.

The Cave of Sclaigneaux.

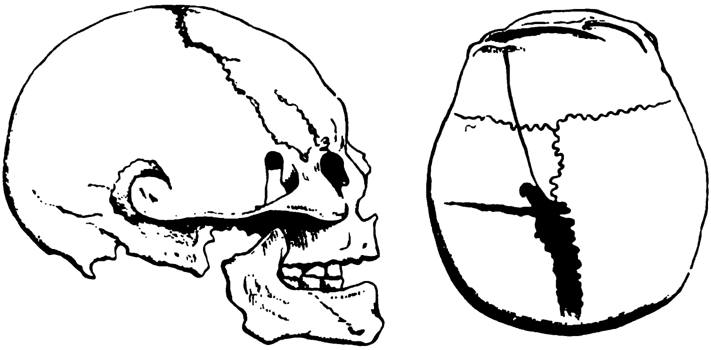
The cave of Sclaigneaux,[1] explored by M. Arnould, near the hamlet of that name, fourteen miles from Namur, has been proved to contain human bones, lying mixed with those of the animals in the refuse-heap on the floor, as in the cave of Chauvaux. The animals belonged to existing species :—

Hedgehog.	Fox.	Rabbit.	Boar.
Badger.	Dog.	Ox.	Horse.
Beech-marten.	Wild Cat.	Goat.	Rodents.
Weazel.	Hare.	Stag.	

Bones of birds, frogs, and fishes were also met with. Intermingled with these were human skeletons, disposed in a rude sort of order, and belonging to bodies which had been interred at different times. From the lower jaws M. Arnould calculates that the number of bodies interred was not less than sixty-two, of which twelve belonged to aged individuals, twenty-one to those in the prime of life, sixteen to young adults, and thirteen to children.

[1] International Congress, Bruxelles, 1872, p. 370.

The crania (Figs. 65, 66) are brachy-cephalic (see Table, p. 199), and are possessed, according to M. Arnould, of the following characters. The apex of the cranial vault is flattened, probably artificially, and the



FIGS. 65, 66.—Skull from Cave of Sclaigneaux. (Arnould.)

parietal bosses are largely developed, to which is due the great width of the skull. The surciliary ridges are strongly marked, and the malar bones are prominent. In all these particulars they agree with the broad skulls, as defined by Dr. Thurnam, discovered in the round tumuli of Britain and the sepulchral caves of France.

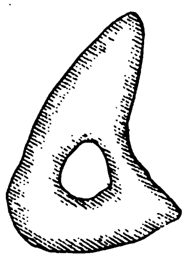


FIG. 67.—Platycnemic tibia, from Sclaigneaux.

Some of the leg-bones presented the antero-posterior flattening, or platycnemism, observed in the skeletons from the caves of Gibraltar, and in France and Great Britain (Fig. 67). It is due, as in those from North Wales, to the anterior expansion of the bone, and not to the posterior, as is the case with those from the cave of Cro-Magnon.

A beautifully chipped arrow-head, with barbs and central tongue for insertion into the shaft, of the same type as one from Chauvaux, implies that these remains belong to the neolithic age. Implements of bone, and a shell perforated for suspension, were also found.

The Evidence of History as to the Peoples of Gaul and Spain.

The extension of this non-Aryan race through France, Spain, and Britain, in ancient times, based solely on the evidence of the human remains, is confirmed by an appeal to the ethnology of Europe within the historic period. In the Iberian peninsula the Basque populations of the west are defined from the Celtic of the east by the Celtiberi inhabiting the modern Castille (see Map, Fig. 68). In Gaul the province of Aquitania extended as far north, in Cæsar's time,[1] as the river Garonne, constituting the modern Gascony, to which was added, in the days of Augustus, the district between that river and the Loire; a change of frontier that was probably due to the predominance of Basque blood in a mixed race in that area similar to the Celtiberi of Castille. The Aquitani were surrounded on every side, except the south, by the Celtæ, extending as far north as the Seine, as far to the east as Switzerland and the plains of Lombardy, and southwards, through the valley of the Rhone and the region of the Volscæ, over the Eastern Pyrenees into Spain. The district round the Phocæan colony of Marseilles was inhabited by Ligurian tribes, who held the region between the river Po and the Gulf of Genoa, as far as the western boundary of Etruria, and who pro-

[1] Cæsar, i. 50.

FIG. 68.—Distribution of Basque, Celtic, and Belgic Peoples, at dawn of History.

bably extended to the west along the coast of Southern Gaul as far as the Pyrenees.[1] They were distinguished from the Celtæ, not merely by their manners and customs, but by their small stature and dark hair and eyes, and are stated by Pliny and Strabo to have inhabited Spain. They have also left marks of their presence in Central Gaul in the name of the Loire (Ligur), and possibly in Britain in the obscure name of the Lloegrians. They invaded Sicily[2] as the Sikelians, and *if* the latter be identified with the Sikanians considered by Thucydides[3] and other writers to be of Iberian stock, it will follow that they are a cognate race. Their stature and swarthy complexion, as well as the ancient geographical position conterminous with the Iberic population of Gaul and Spain, confirm this conclusion. The non-Aryan and probably Basque population of Gaul was therefore cut into two portions by a broad band of Celts, which crosses the Eastern Pyrenees, and marks the route by which the Iberian peninsula was invaded.

The ancient population of Sardinia is stated by Pausanias to be of Libyan extraction, and to bear a strong resemblance to the Iberians in physique and in habits of life, while that of Corsica is described by Seneca as Ligurian and Iberian. The ancient Libyans are represented at the present day by the Berber and Kabyle tribes which are, if not identical with, at all events cognate with the Basques. We may therefore infer that

1 "Bull. Soc. Anthrop de Paris," 2 sér. t. 111., p. 118.

2 "Diodorus Siculus," iv. 6; v. 39. Steur, "Ethnographie des Peuples de l'Europe," p. 31 *et seq.*; Donaldson, "Varronianw." p. 70 *et seq.* Dion. Hal. i. 22. See also Niebuhr and Mommsen. The documentary evidence is so uncertain as to the affinities of the Ligurians that scarcely any two writers agree. "Quot homines tot sententiæ."

3 Thucydides, vi. 2.

these two islands were formerly occupied by this non-Aryan race, as well as the adjacent continents of Northern Africa and Southern Europe.

The Basque Population the Oldest.

The relative antiquity of these two races in Europe may be arrived at by this distribution. The Basques, Sikani or Ligurian, are the oldest inhabitants, in their respective districts, known to the historian; while the Celts appear as invaders, pressing southwards and westwards on the populations already in possession, flooding over the Alps and under Brennus sacking Rome, and by their union with the vanquished in Spain constituting the Celtiberi. We may therefore be tolerably certain that the Basques held France and Spain before the invasion of the Celts, and that the non-Aryan peoples were cut asunder, and certain parts of them left—Ligurians, Sikani, and in part Sardinians and Corsicans—as ethnological islands, marking, so to speak, an ancient Basque non-Aryan continent which had been submerged by the Celtic populations advancing steadily westwards.

At the time of the Roman conquest of Gaul, the Belgæ were pressing on the Celts, just as the latter pressed the Basques, the Seine and the Marne forming their southern boundary, and in their turn being pushed to the east by the advance of the Germans in the Rhine provinces. Thus we have the oldest population, or Basque, invaded by the Celts, the Celts by the Belgæ, and these again by the Germans; their relative positions stamping their relative antiquity in Europe.

The Population of Britain.

The Celtic and Belgic invasion of Gaul repeated itself, as might be expected, in Britain. Just as the Celts pushed back the Iberian population of Gaul as far south as Aquitania, and swept round it into Spain, so they crossed over the Channel and overran the greater portion of Britain, until the Silures, identified by Tacitus[1] with the Iberians, were left only in those fastnesses that formed subsequently a bulwark for the Brit-Welsh against the English invaders. And just as the Belgæ pressed on the rear of the Celts as far as the Seine, so they followed them into Britain, and took possession of the "Pars Maritima,"[2] or southern counties. The unsettled condition of the country at the time of Cæsar's invasion was, probably, due to the struggle then going on between Celts and Belgæ.

The evidence offered by history as to the distribution of these races confirms that which has been arrived at by the examination of the caves and tumuli. In the one case the Basque peoples are merely known in a fragmentary condition in Britain, Gaul, and Sicily, while in the other those fragments are joined together in such a way as to show that, in the neolithic age, they extended uninterrupedly through Western Europe, from the Pillars of Hercules in the south to Scotland in the north, before they were dispossessed by their broad-headed enemies. It is impossible to define with precision their ethnological relation to the non-Aryan inhabitants of Italy and the coasts of the Mediterranean, such as the Etruscans and Tyrrhenians. I

[1] Tacitus, "Agricola," xi. [2] Cæsar, i. 12.

am, however, inclined to hold that they are all branches of the same race of "Melanochroi," differing far less from each other than the Celtic from the Scandinavian branch of the Aryan family.[1]

Basque Element in present British and French Populations.

This non-Aryan blood is still to be traced in the dark-haired, black-eyed, small, oval-featured peoples in our own country in the region of the Silures, where the hills have afforded shelter to the Basque populations from the invaders.[2] The small swarthy Welshman of Denbighshire is in every respect, except dress and language, identical with the Basque inhabitant of the Western Pyrenees, at Bagnères de Bigorre.

The small dark-haired people of Ireland,[3] and especially those to the west of the Shannon, according to Dr. Thurnam and Professor Huxley, are also of Iberian derivation, and singularly enough there is a legendary connection between that island and Spain. The human remains from the chambered tombs as well as the river-beds prove that the non-Aryan population spread over the whole of Ireland as well as the whole of Britain. The main mass of the Irish population is undoubtedly Celtic, crossed with Danish, Norse, and English blood.

[1] Prof. Huxley brings them into relation with the ancient Egyptians, the "Melanochroi" of India, and the Australians, "Critiques and Addresses," p. 134; Prehistoric Congress, Norwich Volume, p. 92 *et seq.*

[2] See Prof. Huxley's "Critiques and Addresses," p. 167.

[3] For a masterly account of the varying stature in Britain and Ireland, see Dr. Beddoe's Essay, "Anthrop. Soc. Mem." iii. p. 384—573.

The Basque element in the population of France is at the present time centered in the old province of Aquitaine, in which the jet-black hair and eyes, and swarthy complexion, strike the eye of the traveller, now as in the days of Strabo,[1] and form a vivid contrast with the brown hair and grey eyes of the inhabitants of Celtica and Belgica (see Map, Fig. 68). If Fig. 68 be compared with the map published by Dr. Broca ("Mémoires d'Anthropologie," t. i. p. 330), which shows at a glance the average complexion prevailing in each department, and the relative number of exemptions per 1,000 conscripts, on account of their not coming up to the standard of height (1·56 metre = 5 feet 1½ inches), it will be seen that the only swarthy people outside the boundary of Aquitaine constitute five ethnological islands. Of these Brittany is by far the largest, probably because its fastnesses afforded a shelter to the Basques, who were being driven to the south-west. The department of the Meuse, in the north, and those of Tarn and Arriège, in the south, are also sundered from the main body, while those of the Upper and Lower Alps present us with the descendants of the ancient Ligurian tribes.

The people with dark-brown hair, considered by Dr. Broca to be the result of the intermingling of a dark with a fair race, are scattered about through Aquitaine, and occur only in two departments in northern Celtica. The fair people, on the other hand, are massed in northern Celtica and Belgica. The relation of complexion to

[1] "*τοὺς μὲν Ἀκυϊτανοὺς τελέως ἐξηλλαγμένους οὐ τῇ γλώττῃ μόνον ἀλλὰ καὶ τοῖς σώμασιν, ἐμφερεῖς Ἴβηρσι μᾶλλον ἢ Γαλάταις· τοὺς δὲ λοιποὺς Γαλατικοὺς μὲν τὴν ὄψιν, ὁμογλώττους δ' οὐ πάντας, ἀλλ' ἐνίους μικρὸν παραλλαττόντας ταῖς γλώτταις.*"—Lib. iv. c. 1, §1.

stature may be gathered from the following table of exemptions per 1,000 for each department:—

Départements	noirs	98·5	to	189
,,	gris-foncés	64·	,,	97
,,	gris-clairs	48·8	,,	63·8
,,	blancs-clairs	23·	,,	48·5

From this table it is evident that the swarthy people are the smallest and the fair the tallest, the intermediate shades being the result of fusion between the two extremes.

The distribution therefore of the small swarthy Basque, and tall fair Celtic and Belgic races in France at the present time, corresponds essentially with that which we might have expected from the evidence both of history and of the neolithic caves and tombs.[1]

When we consider the many invasions of France, and the oscillations to and fro of peoples, the persistence of the Basque population is very remarkable. It is not a little strange that the type should be so slightly altered by intermarriage with the conquering races.

Whence came the Basques?

From what region did the Basques invade Europe? M. Broca, from their identity with the Kabyles and Berbers, holds that they entered Europe from northern

[1] The correspondence of my map, Fig. 68, with that of M. Broca, is one of those undesigned coincidences which are so valuable in arriving at truth, for his most admirable essay on the Ethnology of France did not come into my hands until my own map was engraved. M. Broca takes a different point of view to that advanced in these pages, holding that the Celts were dark and the Belgic were blue-eyed tall Kymri or Cimbri. The Celts known to history were undoubtedly a tall fair race.

Africa, spreading over Spain, and passing over the Pyrenees into southern France. It seems, however, to me, that from their range as far north as Scotland, and at least as far to the east as Belgium, that they travelled by the same route that the Celtic, Belgic, and Germanic tribes travelled long ages afterwards, coming from the east and pushing their way to the west: and that while one section chose this route, another mastered northern Africa, following the same westward direction as the Saracens. On this hypothesis this great pre-Aryan migration would start from the central plateau of Asia, from which all the successive invaders of Europe have swarmed off.

This view of the eastern derivation of the Basque peoples is confirmed by the examination of the breeds of domestic animals which they possessed. The *Bos longifrons*, the sheep, and the goat are derived from wild stocks that are now to be found only in central Asia; and the dog and breed of swine with small canines were also probably imported after they had become the servants of man in the east.[1]

The Celtic and Belgic Brachy-cephali.

The occurrence of broad-skulls in the tumuli in this country, and in caves and tumuli in France, proves that the Basque peoples were invaded during the neolithic

[1] In treating this difficult subject, I have purposely omitted to use the uncertain light of philology. We may expect to derive as much knowledge as to the relations between Tyrrhenian, Ligurian, Basque, and other obscure non-Aryan peoples from the study of languages, as we have already obtained of the Aryans by the same means. It is very probable that, like the Sanscrit, the Basque roots will be found widely spread both in Asia, Asia Minor, Europe, and N. Africa.

age. And since Dr. Thurnam has shown that they are identical in form with Celtic and Belgic skulls,[1] it follows that one or the other of these, probably the Celtic or the older, was in possession of portions of Britain, Ireland, and Gaul at that remote time. It is of course conceivable that non-Celtic races, physically allied to the Celts or Belgæ, are represented by the human remains in question; but in that case they have left no mark behind by which they can be identified. And the supposition is rendered improbable to the last degree by the fact, that the older or conquered race—the Basque—still survives, in the area under consideration, the invasions and vicissitudes which it has undergone. *A fortiori*, would their conquerors have had a still greater chance of survival, in the fastnesses which are offered by these countries. It is therefore reasonable to presume that the broad-headed peoples in the neolithic caves and tombs are represented by the Celts, and possibly, though not probably, in part by the Belgæ, rather than by the equally broad-headed Wends, Sclavonians, and Fins, which are not known by the historian to have set foot in Gaul or in Britain. The successive invasions of Europe have been invariably from the east to the west, so far as we have any certain knowledge; and it is most improbable that Wends, Fins, or Sclaves should have occupied these countries and subsequently have retreated eastwards against the current of the Celtic, Belgic, and Germanic invasions.

The Celtæ may, therefore, be inferred to have occupied Gaul and Britain in the ages of polished stone, bronze, and of iron, their encroachment on the non-Aryan peoples being regulated by their strength, and the amount of

[1] "Anthrop. Mem." Vols. i. and iii. (Crania Britannica.)

pressure on their rear. The Belgæ probably were not known in Gaul until the later portion of the iron age, and were of small importance as compared with the Celts, whose arms were felt alike in Greece, Italy, Spain, and Asia Minor.

The Celts were a tall, fair-haired, blue-eyed race (Xanthochroi), contrasting strongly with the Basque "Melanochroi"), and in those particulars agreeing with the Germans.[1]

The Ancient German Race.

The Germans, in the days of Cæsar, were advancing on the Belgæ in the Rhine provinces, and on the Helvetii in Switzerland, and are recognized by Tacitus,[2] in Britain as the red-haired, tall inhabitants of Caledonia. Subsequently they spread over the west and south of Europe, as Goths, Franks, Scandinavians, English and Normans; in this country sweeping the Brit-Welsh into the hilly fastnesses of Wales, making settlements on many points of the coasts of Ireland, and leaving behind them, to this day, a considerable infusion of German blood in the Celtic and Basque populations. They were, unlike the present inhabitants of North Prussia and southern and middle Germany, a dolicho-cephalic people, their length of head being due, according to Gratiolet, to a frontal instead of an occipital development, which causes the long-headedness of the Basques. The Anglo-Saxon skull is defined by Dr. Thurnam as prognathous, with large facial bones, and with a cephalic index

[1] See Huxley's "Critiques and Addresses," p. 167 *et seq.*

[2] "Rutilæ Caledoniam habitantium comæ, magni artus Germanicam originem asseverant." Agricola, c. xi.

averaging ·75. And these characters are equally to be found in the Gothic, Frankish, and Scandinavian crania.

General Conclusions.

In this outline of the ethnology of Gaul and Britain, it will be seen that two out of the three ethnical elements (if the Belgic be classed with the Celtic), of which the present population is composed, can be recognized in the neolithic users of caves and builders of chambered tombs. A non-Aryan race either identical or cognate with the Basque is the earliest traceable in these areas in the neolithic age, and it probably arrived in Europe by the same route as the Celtic and Germanic, passing westwards from the plains of central Asia.

There is no evidence of Spain having been peopled from northern Africa, the identity of the Berber and Kabyle with the Basque being due to their being descended from the same non-Aryan stock in possession of southern and western Europe, and northern Africa. They are to be looked upon as cousins rather than as connected by descent in a right line.

The Basque race was probably in possession of Europe for a long series of ages, before hordes either identical or cognate with the Celts gradually crept westward over Germany into Gaul, Spain, and Britain, driving away, or absorbing, the inhabitants of the regions which they conquered.

CHAPTER VII.

CAVES CONTAINING HUMAN REMAINS OF DOUBTFUL AGE.

The Caves of Paviland.—Engis.—Trou du Frontal.—Gendron.—Neanderthal.—Gailenreuth.—Aurignac.—Bruniquel.—Cro-Magnon. Lombrive.—Cavillon, near Mentone.—Grotta dei Colombi in Island of Palmaria, inhabited by Cannibals.—General Conclusions.

THERE are many prehistoric caves in Britain and on the Continent which do not contain remains sufficiently characteristic to fix the date of their use, either for occupation or burial, unless the term neolithic be understood to cover the wide interval between the palæolithic stage of the pleistocene on the one hand, and the bronze age on the other.

The Paviland Cave.

The Cave of Goat's Hole[1] at Paviland, in Glamorganshire, explored by Dr. Buckland in 1823, offers an instance of an interment having been made in a pre-existent deposit of the pleistocene age. It consists of a chamber facing to the sea, in a cliff of limestone 100 feet high, at a level of from 30 to 40 feet above the high-water mark. Its floor was composed of red loam, containing the remains of the woolly-rhinoceros, hyæna, cave-bear,

[1] "Reliquiæ Diluvianæ," p. 82 *et seq.*

and mammoth. Close to a skull with tusks of the last animal a human skeleton (equalling in size the largest male skeleton in the Oxford Museum) was discovered; and in the soil, "which had apparently been disturbed by ancient diggings," were fragments of charcoal, a small chipped flint, and the sea-shells of the neighbouring shore. Certain small ivory ornaments, found close to the skeleton, are considered by Dr. Buckland to have been carved out of the tusks of the mammoth near which they rested; and he justly remarks that, "as they must have been cut to their present shape at a time when the ivory was hard, and not crumbling to pieces, as it is at present at the slightest touch, we may from this circumstance assume for them a high antiquity."

May we not also infer, from the fact of the manufactured ivory and the tusks from which it was cut being in precisely the same state of decomposition, that the tusks were preserved from decay, during the pleistocene times, by precisely the same agency as those now found perfect in the polar regions—namely, the intense cold; that after the skull of the mammoth had been buried in the cave, the tusks, thus preserved, were used for the manufacture of ornaments; and that, at some time subsequent to the interment of the ornaments with the corpse, a climatal change has taken place, by which the temperature in England, France, and Germany has been raised, and the ivory became decomposed that up to that time had preserved its gelatine? On this point it is worthy of remark that fossil tusks have been discovered in Scotland sufficiently perfect to be used as ivory. The ornaments may, however, not have been made from the fossil tusks.

The presence of the bones of sheep underneath the remains of mammoth, bear, and other animals, coupled with the state of the cave earth, which had been disturbed before Dr. Buckland's examination of the cave, would prove that the interment is not of pleistocene date. No traces of sheep or goat have as yet been afforded by any pleistocene deposit in Britain, France, or Germany.

Dr. Buckland's conclusion, that the interment is relatively more modern than the accumulation with remains of the extinct mammalia, must be accepted as the true interpretation of the facts. The intimate association of the two sets of remains, of widely diverse ages, in this cave show that extreme care is necessary in cave exploration.

The Cave of Engis.

Human remains have been obtained from some of the caves of Belgium under circumstances which are generally considered to indicate that they are of the same antiquity as the skeletons of the animals with which they are associated. The possibility, however, of the contents of caves of different ages being mixed by the action of water, or by the burrowing of animals, or by subsequent interments, renders such an association of little value, unless the evidence be very decided. The famous human skull discovered by Dr. Schmerling[1] in the cave of Engis, near Liége, in 1833, is a case in point. It was obtained from a mass of breccia, along with bones and teeth of mammoth, rhinoceros, horse, hyæna, and bear; and sub-

[1] Schmerling, "Recherches sur les Ossements Fossiles découverts dans les Cavernes de la province de Liége." 4to. 1833-4, p. 29 *et seq.*

sequently M. Dupont[1] found in the same spot a human ulna, other human bones, worked flints, and a small fragment of coarse earthenware. The discovery of this last is an argument in favour of the human remains being of a later date than the extinct mammalia, since pottery has not yet been proved to have been known to the palæolithic races who co-existed with them, while it is very abundant in neolithic burial-places and tombs. The fact of all the objects being cemented together by calcareous infiltration is no test of relative age, which cannot be ascertained without distinct stratification, such as that in the caves of Wookey and Kent's Hole.

It seems therefore to me, that the conditions of the discovery are too doubtful to admit of the conclusion of Sir Charles Lyell and other eminent writers, that the human remains are of palæolithic age.

The skull is described by Professor Huxley[2] as being of average size, its contour agreeing equally well with some Australian and European skulls; it presents no marks of degradation, " and is in fact a fair average human skull, which might have belonged to a philosopher, or might have contained the thoughtless brains of a savage." Its measurements fall within the limits of the long-skulls described in the preceding chapter, and it certainly belongs to the same class.

[1] Dupont, "L'Homme pendant les âges de la Pierre, dans les environs de Dinant sur-Meuse," p. ix. The implements are palæolithic (see p. 22), but there is no evidence that they are of the same antiquity as the human remains. They may be, and probably are, much older.

[2] " Man's Place in Nature," chap. iii. Lyell's " Antiquity of Man," 1st edition, p. 63.

The following Table will show the variation in size and form of the skulls mentioned in this chapter:

Measurements of Skulls of doubtful antiquity.

	Length.	Breadth.	Height.	Circumference.	Cephalic index.	Altitudinal index
Engis (Huxley)	7·7	5·4	—	20·5	·700	—
Trou du Frontal (Pruner-Bey	6·9	5·6	—	21·55	·811	·704
Gailenreuth (Dawkins) . .	6·82	5·5	—	21·55	·813	·813
Neanderthal (Schaaffhausen)	12·0	5·75	—	23·	·720	—
Cro-Magnon, No. 1 (Broca)	7·95	5·86	—	22·36	·730	—
,, ,, 2 ,,	7·52	5·39	—	21·26	·71	—
,, ,, 3 ,,	7·94	5·94	—	22·24	·74	—

Trou du Frontal.

The human skeletons in the Trou du Frontal, situated in a picturesque limestone cliff on the banks of the Lesse, near Furfooz, are considered by M. Dupont to be of the same age as the contents of the caves close by the Trou des Nutons and Trou Rosette, which have been inhabited by palæolithic savages. The following is the section (Fig. 69) which he gives of the deposits. Close to the river Lesse is the alluvium (No. 1), below which is a clay (No. 2), with angular blocks passing upwards under the rock shelter, and filling the cave. Under this is a stratum of loam (No. 3), resting on gravel (No. 4). Sixteen human skeletons were discovered in the sepulchral cavity (s), at the mouth of which was a large slab of rock (D), by which it was originally blocked up. A singular urn, with a round bottom and with the handles perforated for suspension, was found at the entrance, together with flint flakes, ornaments in fluorine, and eocene shells perforated for

suspension. Outside, at the points H H, was an accumulation of broken bones, belonging to the lemming, tailless hare (Lagomys), beaver, wild cat, boar, horse, stag, urus, chamois, goat, and other animals, birds and fishes. From the occurrence of fragments belonging to two reindeer, it is considered by M. Dupont to belong to the reindeer age. The old hearth was close by, at F (Fig. 69).

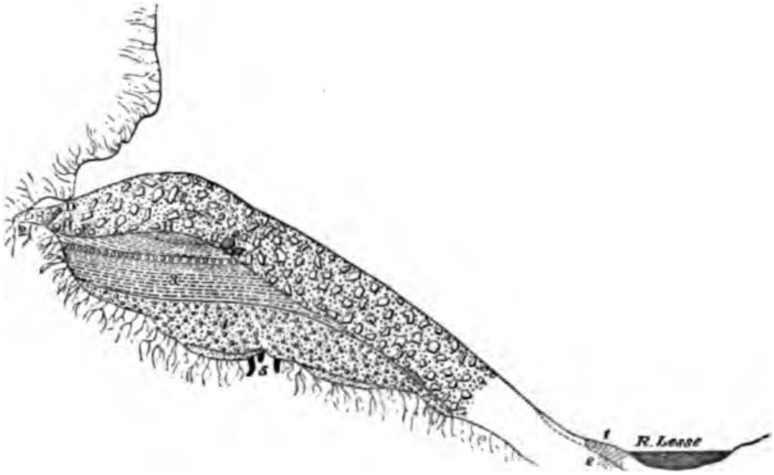


FIG. 69.—Section of the Trou du Frontal. (Dupont.)

From this section we may infer, that the rock-shelter was used by man at the points H H and F before the formation of the stratum No. 2, which is probably merely sub-aerial rain-wash, due to the disintegration of the adjacent rocks, and that the sepulchral cavity was a place of burial either before, or while No. 2 was accumulated. Can we further conclude that there is any necessary connection between the refuse-heap and the sepulchre in point of time? M. Dupont holds that the contents of all the caves in the cliff are palæolithic, and

that the sepulchral cavity is therefore of that age.[1] It seems to me, however, that the evidence in favour of this view is not conclusive. The burial place may have belonged to one people, and the refuse-heaps in the neighbouring caves and *outside* the slab in the rock-shelter of the Trou du Frontal to another. The form of the urn is remarkably like some of those which have been obtained from the neolithic pile-dwellings of Switzerland, and therefore may possibly imply that the interment is of that age.

The human remains were mixed *pêle mêle* with stones and yellow clay within the chamber. Two skulls, sufficiently perfect to allow of measurement, show that their possessors were broad-headed (brachy-cephalic), and of the same type as those of Sclaigneaux. They are considered by the late Dr. Pruner-Bey to belong to the "type Mongoloide," and are believed by M. Dupont to prove that the palæolithic inhabitants of Belgium were a Mongoloid race. They seem, however, to be of the same general order as the broad-skulls from the neolithic caves and tombs of France, and from the round barrows of Great Britain, as well as those from the neolithic tombs of Borreby and Moën in Scandinavia. And they are looked upon by MM. de Quatrefages, Virchow, and Lagneaux,[1] as presenting the same type as that which is to be recognized in the present population of Belgium, in the neighbourhood, for example, of Antwerp.

These affinities may be explained by the view advanced by Dr. Thurnam, that the broad-heads of the British, French, and Scandinavian tombs are cognate

[1] Dupont, *op. cit.* p. 56.

[2] Prehistoric Congress, Brussels, 1872, p. 549 *et seq.*

with the modern Fin; or by the higher generalisation of Prof. Huxley, that the Swiss "Dissentis" skull, the South German, the Sclavonian, and the Finnish, belong to one great race of fair-haired, broad-headed, Xanthochroi "who have extended across Europe from Britain to Sarmatia, and we know not how much further to the east and south."[1]

Besides these broad crania, M. Lagneaux[2] calls attention to a fragment, sufficiently perfect to indicate a skull of the long type (très dolicho-céphale), and that differed from them in many other particulars. In the Trou du Frontal, therefore, there is proof that a long and a short-headed race lived in Belgium side by side, just as a similar association in the cave of Orrouy establishes the same conclusion as to the neolithic dwellers in France. And since skulls of both these types have been discovered in the neolithic caves of Sclaigneaux and Chauvaux, the interment in the Trou du Frontal may probably be referred to that date.

The Cave of Gendron.

The sepulchral cave of Gendron[3] on the Lesse, in which fourteen skeletons were discovered lying at full length, and in regular order, along with one flake and some fragments of pottery, is of uncertain age, since those articles were found at the entrance, and have no necessary connection with the interments. And if they were deposited at the same time, M. Dupont's view that they stamp the neolithic age is rendered untenable by

[1] Huxley and Laing, "Prehistoric Remains of Caithness."
[2] Intern. Congress, Brussels Volume, p. 549.
[3] Dupont, *op. cit.* p. 140.

the fact that flakes and rude pottery were in use as late as the date of the Roman conquest of Britain, and are frequently met with in association with articles of bronze and of iron. And for the same reasons the neolithic age of the human bones in the Trou de Sureau and of the Trou de Pont-à-Lesse is open to considerable doubt. The contents, however, prove these caves to be post-pleistocene.

Cave of Gailenreuth.

The same uncertainty overhangs the age of the interments in the cave of Gailenreuth, in Franconia, from which Dr. Buckland[1] obtained a human skull of the same broad type as that from Sclaigneaux, along with fragments of black coarse pottery, one of which is ornamented with a line of finger-impressions. The skull is remarkable for the great width of the parietal protuberances, and the flattening of the upper and posterior region of the parietal bone. Its measurements are given in the Table, p. 236, from which it will be seen that it belongs to the same class of skulls as those from the neolithic caves and tumuli of France.

Cave of Neanderthal.

The extraordinary skull found in 1857 in the cave of Neanderthal,[2] by Dr. Fuhlrott, with some of the other bones of the skeleton, was not associated with any other

[1] Buckland, "Reliquiæ Diluvianæ." p. 135. These specimens are in the Oxford Museum, and are identified by Lord Enniskillen as having been derived from Gailenreuth.

[2] Schaaffhausen, translated by Busk, "Nat. Hist. Review," April 1861. Huxley, "Man's Place in Nature," iii. p. 156–171. Lyell's "Antiquity of Man," 1st edition, p. 75.

animals from which its age could be inferred. "Under whatever aspect," writes Professor Huxley, "we view this cranium, whether we regard its vertical depression, the enormous thickness of its supraciliary ridges, its sloping occiput, or its long and straight squamosal suture, we meet with ape-like characters, stamping it as the most pithecoid of human crania yet discovered. But Prof. Schaaffhausen states that the cranium, in its present condition, holds 1033·24 cubic centimetres of water, or about 63 cubic inches, and as the entire skull could hardly have held less than an additional 12 cubic inches, its capacity may be estimated at about 75 cubic inches, which is the average capacity given by Morton for Polynesian and Hottentot skulls.

So large a mass of brain as this would alone suggest that the pithecoid tendencies, indicated by this skull, did not extend deep into the organization, and this conclusion is borne out by the dimensions of the other bones of the skeleton, given by Prof. Schaaffhausen, which show that the absolute height and relative proportions of the limbs were quite those of a European of middle stature. The bones are indeed stouter, but this, and the great development of the muscular ridges noted by Dr. Schaaffhausen, are characters to be expected in savages. The Patagonians, exposed without shelter or protection to a climate possibly not very dissimilar from that of Europe at the time during which the Neanderthal man lived, are remarkable for the stoutness of their limb-bones.

In no sense, then, can the Neanderthal bones be regarded as the remains of a human being intermediate between men and apes; at most they demonstrate the existence of a man whose skull may be said to revert

somewhat towards the pithecoid type—just as a carrier, or a poulter, or a tumbler may sometimes put on the plumage of its primitive stock, the *Columba livia*."

This skull, like the preceding, belongs to the dolichocephalic division, reaching the enormous length of twelve inches, with a parietal breadth of 5·75.

A long-skull found near Ledbury Hill in Derbyshire, and belonging to the river-bed type of Prof. Huxley, comes so close to this one of Neanderthal, that were it flattened a little and elongated, and possessed of larger supraciliary ridges, it would be converted into the nearest likeness which has yet been discovered.[1]

The Caves of France.—Aurignac.

In the cave of Neanderthal, the question of the antiquity of the human remains is not complicated by the juxtaposition of extinct pleistocene animals or of palæolithic implements. Those caves, however, in France which claim especial attention, Aurignac, Bruniquel, and Cro-Magnon, are equally famous for their interments, and the palæolithic implements which they have furnished, along with the remains of the mammoth, woolly rhinoceros, and other extinct animals.

They have both been inhabited by palæolithic man, and been used some time for burial. Does the period of habitation coincide with that of the burial? This important question has been answered almost universally in the affirmative, and the interments are viewed as evidence of a belief in the supra-natural among the most ancient inhabitants of Europe, as well as offering examples of their physique.

[1] Huxley and Laing, "Prehistoric Remains of Caithness," p. 115.

The famous cave of Aurignac, near the town of that name, in the department of the Haute Garonne, was explored and described by the late M. Ed. Lartet, and his conclusions were adopted by Sir Charles Lyell in the first three editions of the "Antiquity of Man." In the fourth edition,[1] however, the latter author, after a reconsideration of all the circumstances, qualifies his acceptance of the palæolithic age of the interments, and shares the doubts which have been expressed by Sir John Lubbock and Mr. John Evans. The evidence is as follows :—

M. Lartet's account falls naturally into two parts: first, the story which he was told by the original discoverer of the cave; and, secondly, that in which the results of his own discoveries are described. We will begin with the first. In the year 1852, a labourer, named Bonnemaison, employed in mending the roads, put his hand into a rabbit-hole (Fig. 70, *f*), and drew out a human bone, and having his curiosity excited, he dug down until, as his story goes, he came to a great slab of rock. Having removed this, he discovered on the other side a cavity seven or eight feet in height, ten in width, and seven in depth, almost full of human bones, which Dr. Amiel, the Mayor of Aurignac, who was a surgeon, believed to represent at least seventeen individuals. All these human remains were collected, and finally committed to the parish cemetery, where they rest to the present day, undisturbed by sacrilegious hands. Fortunately, however, Bonnemaison in digging his way into the grotto, had met with the remains of extinct animals, and works of art; and these were

[1] Compare Lyell, 1st edition, p. 182 *et seq.*, with 4th edition, p. 122 *et seq.*

preserved until, in 1860, M. Lartet accidentally heard of the discovery, and investigated the circumstances on the spot. He found that Bonnemaison, and the sexton who had buried the human remains, had taken so little note of the place where they were interred, that it could not be identified, and on examining the cave he found that the interior had been ransacked, and the original stratification to a great extent disturbed. M. Lartet's exploration showed that a stratum containing the remains of the cave-bear, lion, rhinoceros, hyæna, mammoth, bison, horse, and other animals, and palæolithic implements, like those of Périgord, extended from the plateau (*d*) outside into (*b*) the cave. On the outside he met with ashes, and burnt and split bones, which proved that it had been used as a feasting-place by the palæolithic hunters; within he detected no traces of charcoal, and no traces of the hyænas, which were abundant outside. Inside he met with a few human bones in the earth which Bonnemaison had disturbed, which were in the same mineral condition as those of the extinct animals, and he, therefore, inferred that they were of the same age. Such is the summary of the facts which M. Lartet discovered. He has, of his own personal knowledge, only proved that Aurignac was occupied by a tribe of hunters during the palæolithic age, and that it had been used as a burial-place.

Is he further justified in concluding that the period of palæolithic occupation coincides with that in which the burial took place? Bonnemaison's recollections may be estimated at their proper value by the significant fact, that, in the short space of eight years intervening between the discovery and the exploration, he had forgotten where the skeletons had been buried. And

even if his account be true in the minutest detail, it does not afford a shadow of evidence in favour of the cave having been a place of sepulchre in palæolithic times, but merely that it had been so used at some time or another. If we turn to the diagram constructed by M. Lartet to illustrate his views ("Ann. des Sc. Nat. Zool.," 4e sér., t. xv., pl. 10), and made for the most part from Bonnemaison's recollections; or to the amended diagram (Fig. 70) given by Sir Charles Lyell ("Antiquity of Man," 1st ed., Fig. 25), we shall see that the skeletons are depicted *above* the stratum (*b*) containing the palæolithic implements and pleistocene mammalia; and therefore, according to the laws of geological

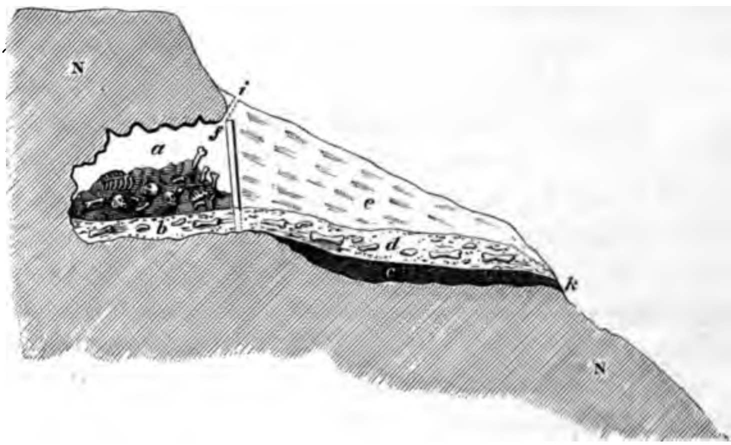


FIG. 70.—Diagram of the Cave of Aurignac.

evidence, they must have been buried after the subjacent deposit was accumulated. The previous disturbance of the cave-earth does away with the conclusion, that the few human bones found by M. Lartet are of the same age as the extinct mammalia in the deposit. The absence of charcoal inside was quite as likely to be

due to the fact that a fire kindled inside would fill the grotto with smoke, while outside the palæolithic savage could feast in comfort, as to the view that the ashes are those of funereal feasts in honour of the dead within, held after the slab had been placed at the entrance. The absence of the remains of hyænas from the interior is also negative evidence, disproved by subsequent examination.

The researches of the Rev. S. W. King, in 1865, complete the case against the current view of the palæolithic character of the interments, since they show that M. Lartet did not fully explore the cave, and that he consequently wrote without being in possession of all the facts. The entrance was blocked up, according to Bonnemaison, by a slab of stone, which, if the measurements of the entrance be correct, must have been at least nine feet long and seven feet high, placed, according to M. Lartet, to keep the hyænas from the corpses of the dead. It need hardly be remarked, that the access of these bone-eating animals to the cave would be altogether incompatible with the preservation of the human skeletons, had they been buried at the same time. The enormous slab was never seen by M. Lartet, and it did not keep out the hyænas. In the collection made by the Rev. S. W. King from the interior there are two hyænas' teeth, and nearly all the antlers and bones bear the traces of the gnawing of these animals. The cave, moreover, has *two* entrances instead of one, as M. Lartet supposed when his paper in the "Annales" was published. The bones of the sheep, or goat, also obtained from the inside, and preserved in the Christy Museum, afford strong evidence that the interment is not palæolithic; and a fragment of pottery, agreeing exactly with that

used in the neolithic age, probably indicates its relative antiquity. This conclusion has also been arrived at by the two most recent explorers, MM. Cartaillac and Gautier.

The skeletons, therefore, in the Aurignac cave cannot be taken to be of the same age as the stratum on which they rested; but, so far as there is any evidence, may probably be referred to the neolithic age, in which the custom of burial in caves prevailed throughout Europe.

Cavern of Bruniquel.

The famous cavern of Bruniquel, explored by the Vicomte de Lastic in 1863-4,[1] and described by Professor Owen, is also one of the class which has furnished human bones, along with the remains of the extinct mammalia. It penetrates a cliff in the Jurassic limestone, opposite the little village of Bruniquel (Tarn and Garonne), about forty feet above the level of the river Aveyron. The bottom was covered with a sheet of stalagmite, resting on earth and blocks of stone, for the most part finely cemented into a breccia, that is black with the particles of carbon constituting the "limon noir" of the workmen, four or five feet thick, beneath which is the "limon rouge," or red earth without charcoal, from three to four feet thick. Every part of the breccia is charged with the broken remains of the wolf, rhinoceros, horse, reindeer, stag, Irish elk and bison, and palæolithic implements of flint and bone; some of the latter having well-executed designs of the heads of horses and reindeer, which prove that the cave had been used as a place of habitation by the hunters of those animals. Imbedded in the breccia at a depth of from three to five feet human bones were met

[1] Phil. Trans. 159, p. 517.

the preceding figure, which I am kindly allowed to borrow from the "Reliquiæ Aquitanicæ" (Fig. 39).

At the time of its discovery in 1868, in the course of making an embankment for the railway close by, and of obtaining material for mending the roads, it was completely blocked up. On the removal of this (*b*), by the contractors MM. Bertoú-Meyroú and Delmarés, the entrance was exposed, and human remains and worked flints revealed, which were carefully exhumed in the presence of MM. Laganne, Galy, and Simon. At this stage of the exploration M. Louis Lartet was deputed, by the Minister of Public Instruction, to superintend the work, and from his report the following account is taken (Lartet and Christy, "Rel. Aq.," p. 66) by the courtesy of the editors.

"The cave of Cro-Magnon is formed by a projecting ledge of cretaceous limestone (rich with fossil corals and polyzoans), having a thickness of 8 metres and a length of 17 metres (Fig. 72, P). The bed which it overlies, and the destruction of which has given rise to the cave, abounds with *Rhynchonella vespertilio*, which is a type fossil, fixing the geological horizon. The débris of this marly and micaceous limestone had accumulated on the original floor of the cavern to a great thickness, at least for 0·70 metres (see Fig. 72, A), when the hunters of the reindeer stopped here for the first time, leaving as a trace of their short stay a blackish layer (Fig. 72, B), from 0·05 to 0·15 metre thick, containing worked flints, bits of charcoal, broken or calcined bones, and in its upper portion the elephant tusk before alluded to (Fig. 72, *a*).

"This first hearth is covered by a layer (C), 0·25 metre thick, of calcareous débris, detached bit by bit from the

roof, during the temporary disuse of the shelter. Then follows another thin layer of hearth-stuff (D), 0·10 metre thick, also containing pieces of charcoal, bones, and worked flints. This bed is in its turn overlain by a

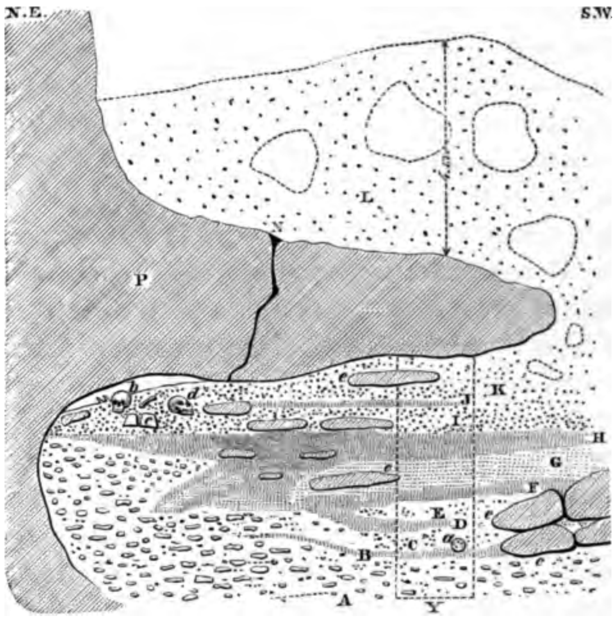


FIG. 72.—Detailed Section of the Cave of Cro-Magnon, near Les Eyzies. Scale = $\frac{1}{100}$ (1 centimetre to 1 metre).

A Débris of soft limestone.
B First layer of ashes, &c.
C Calcareous débris.
D Second layer of ashes, &c.
E Calcareous débris, reddened by fire under the next layer of ashes, &c.
F Third layer of ashes, &c.
G Red earth, with bones, &c.
H Thickest layer of ashes, bones, &c.
I Yellowish earth, with bones, flints, &c.
J Thin bed of hearth-stuff.
K Calcareous débris.
L Rubbish of the Talus.
N Crack in the projecting ledge of rock
P Projecting shelf of hard limestone.
Y Place of the pillar made to support the roof.
a Tusk of an elephant.
b Bones of an old man.
c Block of gneiss.
d Human bones.
e Slabs of stone fallen from the roof at different times.

layer of fallen limestone rubbish (E), 0·50 metre thick. Lastly, there is over these a series of more important layers, all of them containing, in different proportions,

partly repaired within; indeed our physicians think that she survived several weeks. By the side of the woman's skeleton was that of an infant which had not arrived at its full time of fœtal development. The other skeletons (Fig. 70, *d*) seem to have been those of men.

"Amidst the human remains lay a multitude of marine shells (about 300), each pierced with a hole, and nearly all belonging to the species *Littorina littorea* so common on our Atlantic coasts. Some other species, such as *Purpura lapillus, Turritella communis*, &c., occur, but in small numbers. These are also perforated, and, like the others, have been used for necklaces, bracelets, or other ornamental attire. Not far from the skeletons, I found a pendant or amulet of ivory, oval, flat, and pierced with two holes. M. Laganne had already discovered a smaller specimen; and M. Ch. Grenier, schoolmaster at Les Eyzies, has kindly given me another, quite similar, which he had received from one of his pupils. There were also found near the skeletons several perforated teeth, a large block of gneiss, split and presenting a large smoothed surface; also worked antlers of reindeer, and chipped flints, of the same types as those found in the hearth-layers underneath.

". . . . The presence, at all levels, of the same kind of flint scrapers, as finely chipped as those of the Gorge d'Enfer, and of the same animals as in that classic station, evidently shows them to be relics of the successive habitation of the Cro-Magnon shelter by the same race of nomadic hunters, who at first could use it merely as a rendezvous, where they came to share the spoils of the chase taken in the neighbourhood; but coming again, they made a more permanent occupation,

until their accumulated refuse and the débris gradually raised the floor of the cave, leaving the inconvenient height of only 1·20 metre between it and the roof; and then they abandoned it by degrees, returning once more at last to conceal their dead there. No longer accessible, except perhaps to the foxes above noticed, this shelter, and its strange sepulture, were slowly and completely hidden from sight by atmospheric degradation bringing down the earthy covering, which, by its thickness, alone proves the great antiquity of the burial in the cave."

These conclusions as to the age of the burial do not seem to me to be supported by the facts of the case. That the cave was inhabited by a tribe of palæolithic hunters there can be no doubt, but no evidence has been brought forward that it was used by them for the burial of their dead. They "abandoned it by degrees," but what proof is there that *they* "returned once more to conceal their dead"? The interments are at a higher horizon than the strata of occupation, and therefore later, and although palæolithic implements have been found "near" them, the value of the latter, in indicating the date, is destroyed by their occurrence throughout the old floors below. If we suppose that long after the cave had been inhabited by the hunters of the reindeer, it was chosen by a family as a burial-place, all the conditions of the discovery will be satisfied. The pre-existent strata would be disturbed in the process of burial, and the burrowing of foxes, and possibly of rabbits, might bring the palæolithic implements into close association with the human bones. Taking the whole evidence into account, I should feel inclined to assign the interment to the neolithic age, in which cave-burial was so common; but whatever

view be held, the facts do not warrant the human skeletons being taken as proving the physique of the palæolithic hunters of the Dordogne, or as a basis for an inquiry into the ethnology of the palæolithic races.

The largest cranium (see Table, p. 236), belonging to an old man, had the frontal region well developed, is orthognathic, with upturned nasals, and dolicho-cephalic. The occipital protuberance, or probole, is small. The bones of the extremity imply a stature of not less than five foot eleven inches for the man; the femur is carinate, and the tibiæ platycnemic (see Fig. 48).

The Cave of Lombrive.

The human bones, obtained by MM. Garrigou, Filhol, and Rames, from the cave of Lombrive[1] in the Department of Ariège, are, equally with those cited above, of doubtful antiquity. They were discovered on the superficial sandy loam, passing in places into a calcareous breccia, which rests at various levels in the chambers, passages, and fissures, along with bones of the brown-bear, urus, small ox, reindeer, stag, horse, and dog. From the occurrence of the reindeer the deposit is assigned to the palæolithic age. But since this animal has been proved to have been eaten in Scotland by the neolithic men of Caithness, and to have inhabited Britain in the prehistoric age, it is by no means improbable that it may also have lived in the region of the Pyrenees in post-pleistocene times. The presence of the dog and the small domestic ox (*Bos longifrons*?) fixes the date of the accumulation as not being earlier than prehistoric;

[1] Vogt, "Lectures on Man," pp. 329–380. Thurnam, "Anthrop. Mem." i. 501.

for both those animals were introduced into Europe by neolithic peoples.

The two human skulls, described by Professor Vogt, from this deposit confirm this conclusion, since they are of the broad type, and differ in no important character (Thurnam) from those of the neolithic brachy-cephali of France and Belgium.

The Cave of Cavillon, near Mentone.

The cave of Cavillon, explored by M. Rivière, in 1872, in the neighbourhood of Mentone, a few hundred yards on the Italian side of the frontier of France, is another case of the occurrence of human remains in association with those of the extinct animals. The floor is composed of dark earth, full of charcoal and fragments of bones, mingled with blocks of stone which have dropped from the roof. Below it, at a depth of six and a half metres, a skeleton was met with, as well as flint-flakes, rude instruments of bone, and a number of shells perforated for suspension. The skull was covered with a head-dress of more than 200 perforated sea-shells. It rested in an attitude of repose, with the legs and arms bent,[1] as may be seen in the admirable photo-lithograph given by M. Rivière in the volume of the "International Congress of Prehistoric Archæology," published at Brussels, pl. 6. The teeth and bones of hyæna, lion, woolly rhinoceros, mammoth, and other pleistocene animals occurred both in the soil above and below, and for that reason both the discoverer and Sir Charles Lyell believe that the interment dates back to the time when those animals were

[1] It has been dug out in its natural position, and is now to be seen in the Jardin des Plantes, in Paris, where I studied it in the summer of 1873.

living. If, however, neolithic savages, or those of a later age, had buried the skeleton in the earth containing the extinct animals, all the circumstances which have been noticed, either by Mr. Pengelly or Mr. Moggridge,[1] may be satisfactorily explained. There are no stalagmites to divide one stratum from another, and were an interment made in the cave at the present time, the discoverer two or three centuries hence might assert, with equal justice, that it took place in the pleistocene age, because of the association with the animals characteristic of that remote period.

The superficial portions of the cave-earth had certainly been disturbed, and there is no evidence that the disturbance did not extend down to the horizon where the skeleton rested. Nevertheless, Mr. Pengelly concludes that the interment is of palæolithic age from its analogy with that of Cro-Magnon and Paviland, which we have seen to be of equally doubtful antiquity. It seems to me that this conclusion, which is almost universally accepted, is not warranted by the facts, and that it cannot be used in support of any speculation as to the condition of man in the pleistocene age.

The skull is described by M. Rivière as long, the thigh-bones are strongly carinate, and the tibiæ are platycnemic as in the case of those from Cro-Magnon, Gibraltar, Sclaigneaux, and North Wales.

Grotta dei Colombi in Island of Palmaria, inhabited by Cannibals.

We are indebted to Professor Capellini for an account of the exploration of the Grotta dei Colombi, a cave in a

[1] Pengelly, "The Cave Man of Mentone," Trans. Devon Ass. 1873. Moggridge, Brit. Ass. Edinburgh, 1873.

vertical cliff in the island of Palmaria,[1] overlooking to the south the Gulf of Spezzia. In the red loam, composing the floor, were numerous flakes and scrapers, a rounded "striker" of Saussurite, quartz, pebbles, fragments of pottery, a bone needle, a whistle made of the first phalange of a goat's foot, shells perforated for suspension, *Natica mille-punctata*, *Pectunculus glycimeris*, and *Patella cærulea*, together with bones of goat, hog, ox, wolf, wild cat, and broken and cut human bones belonging to children and young adults.

Among the remains Professor Capellini draws attention in particular to the thigh-bones, scorched by fire, one of which bears incisions on its posterior face made by a flint implement in cutting away the flesh (Pl. 73, *a*), and is also marked by scraping. He considers that they belong to an ape, closely allied to the *Macacus innuus* of Gibraltar and North Africa, and concludes, therefore, that the animal was living in Palmaria at the time that the cave was inhabited. This identification is forbidden by the spongy texture, the rounded contour, and the absence of epiphyses that imply that the bone was very young, and that in the adult it would be far larger than any thigh-bone of the apes. On comparing his figures with eight femora belonging to young children, from the cairn at Cefn, and the caves at Perthi-Chwareu, I find that they agree in every particular with two, the flattening of the inferior extremity, considered by Prof. Calori to be a non-human character, being equally met with in all, and being relatively greater in the younger than the older. They offer, therefore, unmistakeable proof that the inhabitants of the cave were cannibals (Fig. 73). I am informed by my friend, Prof. Busk,

[1] Prehistoric Congress, Bologna Volume, p. 391, 1873.

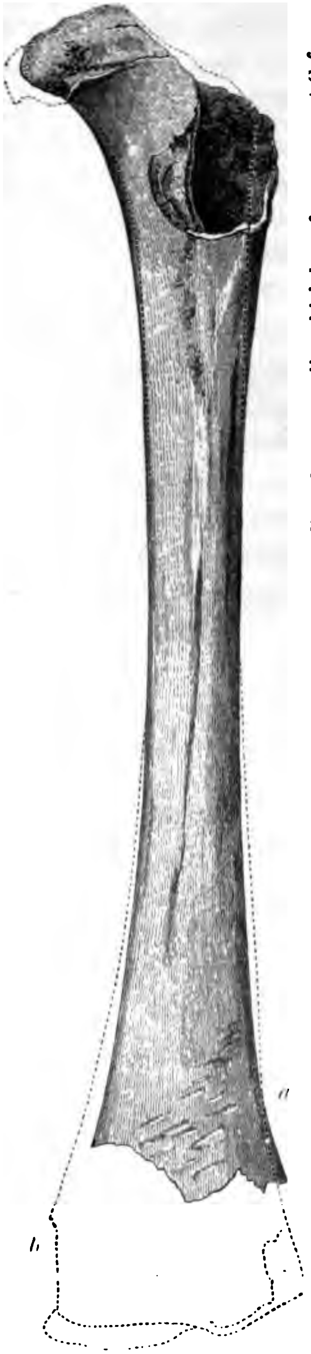


FIG. 73. Thigh-bone of child from Grotta dei Colombi (Capellini). *a*, Cuts; *b*, Outline of corresponding thigh-bone from cavern at Cefn.

that the bone figured belonged to a child about eight years old. The outline *b* in the figure represents the contour of one of the femora from the cavern at Cefn, described in the fifth chapter.

In this cave, as in those quoted above, there are no polished stone implements, or works of art, that establish that these feasts were carried on in the cave by neolithic cannibals, for the rude flint-flakes and bone articles, taken by Professor Capellini to fix its date, are common both to the palæolithic and the bronze ages. Nevertheless, since the inhabitants have left behind no trace of any metal, and since their food was wholly supplied by the existing animals, they were probably in the neolithic stage of culture, if this be taken to cover the wide interval extending from the pleistocene to the age of bronze. They are proved, by the rudeness of their implements, to have been savages of a very low order.

We may gather from various allusions, and stories scattered through the classical writers, such for example as that of the Cyclops, that the caves on the shores of the Mediterranean were inhabited by cannibals in ancient times. In the island of Palmaria we meet with unmistakeable proof that it was no mere idle tale or poetical dream. But we have no proof that cannibalism was universally practised at any stage in the history of man. All the caves of Europe, explored up to the present time, merely afford some three or four examples in the neolithic and bronze ages. In the pleistocene there is no instance which is devoid of doubt. This atrocious practice is therefore to be viewed as abnormal, and it probably became ingrafted into the religious ideas of the nations of antiquity from the horror by which it was surrounded, ultimately surviving in the form of human sacrifices to the offended gods.

General Conclusions as to Prehistoric Caves.

We have seen in the fifth and sixth chapters that the prehistoric caves which are so unimportant in the ages of bronze and iron, were used in the neolithic age throughout western Europe both for habitation and burial, and that they therefore offer us most valuable materials for working out the ethnology of Europe at that remote time. The two races of men, the remains of which they contain, are represented by the modern Basque and Berber on the one hand, and on the other by the Celt, and in Russia and Germany by the cognate Finn, Sclave, and Wend. And since all the human remains described in the present chapter, those of Cro-Magnon and possibly of

the Grotta dei Colombi being exempted, belong to one or other of these types, they may be referred to the neolithic age with a high degree of probability. In the present stage of the inquiry, it is much safer to put them into a distinct class, apart from those to which we can assign a relative age with tolerable certainty.

In the long ages which elapsed between the close of the pleistocene period and the dawn of history other races than these may have occupied Europe, and have passed away without leaving any clue as to their identity. But in the present state of our knowledge we are justified only in concluding, that the oldest population in prehistoric times was non-Aryan, the traces of which are left behind not merely in the caves and tombs, but in language,[1] and in the small dark-haired inhabitants of western and southern Europe.

The prehistoric peoples lived under physical conditions very different from those of central and western Europe at the present time; the surface of the country being covered with rock, forest, and morass, which afforded shelter to the elk, bison, urus, stag, megaceros, and wild boar, as well as to innumerable wolves. They arrived from the east with cereals and domestic animals, some of which, such as the *Bos longifrons* and *Sus palustris*, reverted to their original wild state. From the very exigencies of their position they lived partly by hunting, and they gradually pushed their way westward, carrying with them the rudiments of that civilization which we ourselves possess.

[1] See on this point a valuable essay by Mr. Hyde Clark, "Palestine Exploration Fund Quarterly Statement," N.S. April 1871, p. 97 *et seq.*

It is an open question whether they came into contact with the palæolithic races which preceded them.

The climate which they enjoyed was sufficiently severe to allow the reindeer to inhabit the district on which now stands the city of London, and its severity may also be inferred from the thickness of the bark of the Scotch firs, observed by Mr. Godwin-Austen in the submarine forests of the south of England, and by Mr. James Geikie in those of Scotland. The area of Great Britain was greater then, than now, since a plain extended seawards from the coast-line, nearly everywhere, supporting a dense forest of Scotch fir, oak, birch, and alder, the relics of which are to be seen in the beds of peat, and the stumps of the trees, near low-water mark on most of our shores. And it may be inferred that the forest extended a considerable distance from the present sea margin, from the large size of the trunks of the trees.[1]

[1] The authorities for these facts will be found in my "Preliminary Treatise," Palæont. Soc. 1874. The prehistoric age of the forest is to be fixed by the presence of the goat and *Bos longifrons*, both of which were unknown in Europe in the pleistocene age.

CHAPTER VIII.

THE PLEISTOCENE CAVES OF GERMANY AND GREAT BRITAIN.

Relation of Pleistocene to Prehistoric Period.—**Magnitude of the Interval.—Animals.—Physical changes.—Excavation and filling up of Valleys : Fisherton ; Freshford.—Comparison of Deposits in Valleys with those of Caves.—Differences of Mineral Condition.—The Pleistocene Caves of Germany : Gailenreuth ; Kühloch.—Of Great Britain.—The Caves of Yorkshire : Kirkdale.—Of Derbyshire : The Dream Cave.—Of North Wales, near St. Asaph.—Of South Wales, in counties of Glamorgan, Caermarthen, Pembroke.—Of Monmouth.—Of Gloucestershire.—Of Somersetshire : Uphill, Banwell, Bleadon, Sandford Hill, Wookey Hole.—The District of Mendip higher in Pleistocene age than now.—The condition of bones gnawed by Hyænas.—The Caves of Devonshire : Oreston ; Brixham ; Kent's Hole.—The probable age of the Machairodus of Kent's Hole.—Those of Ireland, Shandon.**

Relation of Pleistocene to Prehistoric Period.

WE have seen, in the fifth and sixth chapters, that the caves offer valuable information as to the prehistoric ethnology of Europe, and that they prove the ancient neolithic population to stand directly related to the Basque and Celtic elements in the present inhabitants of Britain, France, and Spain. We shall discover in the course of this and the following chapters that no such

continuity can be made out between the palæolithic man of the pleistocene age and any of the races now living in our quarter of the world; and we shall see that he is separated from his neolithic successor by an interval of time, the length of which cannot be measured in terms of years. Before the pleistocene group of caves be examined, it will be necessary to define the relation that exists between the prehistoric and the pleistocene periods.

The Animals—Magnitude of Interval.

The prehistoric mammalia consist, as we have seen (p. 136), with the solitary exception of the Irish elk, of the wild animals at present living in Europe, together with the domestic species and varieties introduced by man, probably from central Asia. In the rest of this work we shall have to deal, not merely with the wild animals at present inhabiting Europe, but also with those which have either become extinct, or have migrated to Asia, America, or Africa. Besides this addition to the European fauna in the pleistocene age, the total absence of the domestic animals is a most important feature. The dog, goat, sheep, Celtic short-horn, and domestic swine are conspicuous by their absence: the reputed association of their remains with those of the pleistocene mammals being due, in all the cases which I have examined in France and Britain, to a confusion between distinct strata in the same cave or river-deposit, which are respectively of pleistocene and prehistoric or historic ages. Thus in the excavations in the gravel underneath London, the Celtic short-horn and goat of the superficial strata are very generally mixed with the

reindeer and mammoth of the pleistocene gravels below, by the collectors, and the names of the domestic animals have crept into the pleistocene lists. None of the domestic animals have been recorded from any carefully explored strata of that age in any part of Europe.

The following late pleistocene species were unknown in Britain in the prehistoric age :—

Glutton.	Pouched marmot.
Spotted hyæna.	Tailless hare.
Panther.	*Lepus diluvianus.*
Lion.	*Arvicola Gulielmi.*
Lynx.	Cave-bear.
Felis Caffer.	*Rhinoceros hemitœchus.*
Musk-sheep.	*R. tichorhinus.*
Bison.	*Elephas antiquus*
Hippopotamus.	Mammoth.
Lemming.	

The glutton, lynx, bison, and lemming, still live in Europe, the spotted hyæna, *Felis Caffer*, and hippopotamus are peculiar to Africa, the lion to Africa and Asia, and the last seven species are extinct. The *Machairodus cultridens* and *Rhinoceros megarhinus* probably disappeared in an early stage of the pleistocene. It may reasonably be inferred, from the migration and extinction of so many species between the close of the pleistocene and beginning of the historic period, that the interval was of considerable length ; for it would be impossible for such changes to have taken place in a short time.

The same sharp line of demarcation exists between the two faunas on the continent. The panther, *Felis Caffer*, lynx, spotted hyæna, musk-sheep, hippopotamus, and the extinct group disappeared. The African elephant forsook Spain and Sicily, the striped hyæna the south of France, before the prehistoric period : while the *Elephas*

meridionalis and pigmy hippopotamus of Sicily, and the pigmy elephant and gigantic dormouse of Malta, became extinct. Speaking in general terms, the wild fauna of Europe, as we have it now, dates from the beginning of the prehistoric age, and consists merely of those animals which were able to survive the changes by which their pleistocene congeners were banished or destroyed. The arrival of the domestic animals under the care of man in the neolithic age, and their extension over the whole of Europe in a wild or semi-wild state, coupled with the disappearance of the wild species mentioned above, constitutes a change in the mammal life at least as important as any of those which define the meiocene from the pleiocene, or the pleiocene from the pleistocene periods.

Physical changes—The excavation and filling up of Valleys.

The magnitude of the interval between the two periods may also be gathered from the great changes which have taken place in physical geography. In nearly every valley in Great Britain, certain areas to be mentioned presently excepted, are strata of sand and gravel, proved to be of pleistocene age by their fossil mammals, and by their fluviatile shells to have been deposited by rivers. They occur at various heights, forming sometimes terraces, and at others isolated patches, which were accumulated when the river flowed at their level, and before the valleys were cut down to their present depth. Those at Fisherton near Salisbury, described by Sir Charles Lyell, Mr. Prestwich, Mr. John Evans,[1] and others, may be taken as an example.

[1] "Quart. Geol. Journ." xx. p. 188 *et seq.*

The valley through which the river Wily flows is excavated in the chalk (Fig. 74), and on its northern side fluviatile deposits occur at two levels, represented in the accompanying section. One patch of gravel, about twelve feet thick, *a*, lies about eighty feet above the present level of the Wily; while a second, *b*, consisting of clayey brickearth or loam, with seams of gravel, and fluviatile shells, sweeps down from a lower point to the

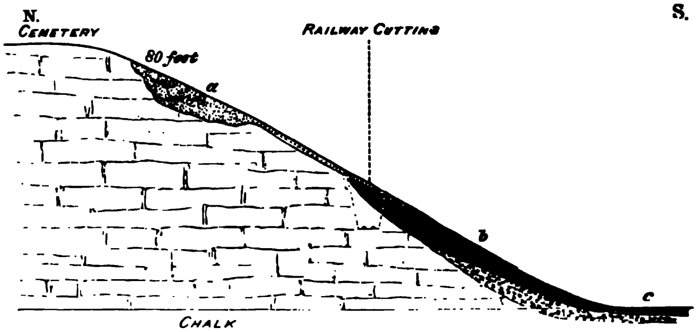


FIG. 74.—Section of Valley-gravels at Fisherton. (Evans.)

bottom of the valley, and passes under the river. From the deposit *a*, Dr. Blackmore obtained many rudely-chipped implements, of the same palæolithic type as those found with the extinct mammalia in the gravel beds at Amiens and Abbeville in the valley of the Somme. In the deposit *b*, fossil mammalia were met with belonging to the following animals:—

Spotted hyæna.	Wild boar.
Lion.	Horse.
Reindeer.	Woolly rhinoceros.
Stag.	Mammoth.
Bison.	Lemming.
Urus.	Pouched marmot.
Musk-sheep.	Hare.

Dr. Blackmore subsequently discovered a flint implement along with these animals, of the same type as those previously met with in the deposit *a*.

A horizontal stretch of alluvium, *c*, deposited by the floods, occupies the present bottom of the valley. In this section it is plain that the gravels and brickearth at *a* and *b* were deposited by a river, which formerly flowed at those levels. In other words, the valley of the Wily was excavated during the time that the pleistocene strata *a* and *b* were being formed, while palæolithic man and the extinct animals were living in the neighbourhood. The position also of *b* below the present bottom of the valley proves that the latter then was deeper than it is now. The prehistoric alluvium, *c*, represents the last stage in the history of the valley in which it is beginning to be filled with the deposits of floods. While it was being accumulated none of the animals of *a* and *b* were living in the district except the hare, urus, stag, horse, and wild boar.

A somewhat similar section is exposed in the valley of the Avon at Freshford, near Bath, in a railway cutting, at a height of about thirty-five feet above the river. A thick mass of gravel abuts directly against a cleft of inferior oolite (Fig. 75), and gradually dies down to the alluvium. In it Mr. Charles Moore discovered the remains of the musk-sheep, and the Rev. H. H. Winwood those of the mammoth, bison, horse, and reindeer. In this case the pleistocene strata occupied the side of one of the valleys which had been deepened since the time of their deposit.

The alluvium in the neighbourhood of Bath contains in its lower portion a layer of peat, with bones of the Celtic short-horn (*Bos longifrons*), stag, roe, horse, goat, and pig; and in its upper part are old refuse heaps,

proved to be Roman by the coins and ware, which are also met with at various points underneath the

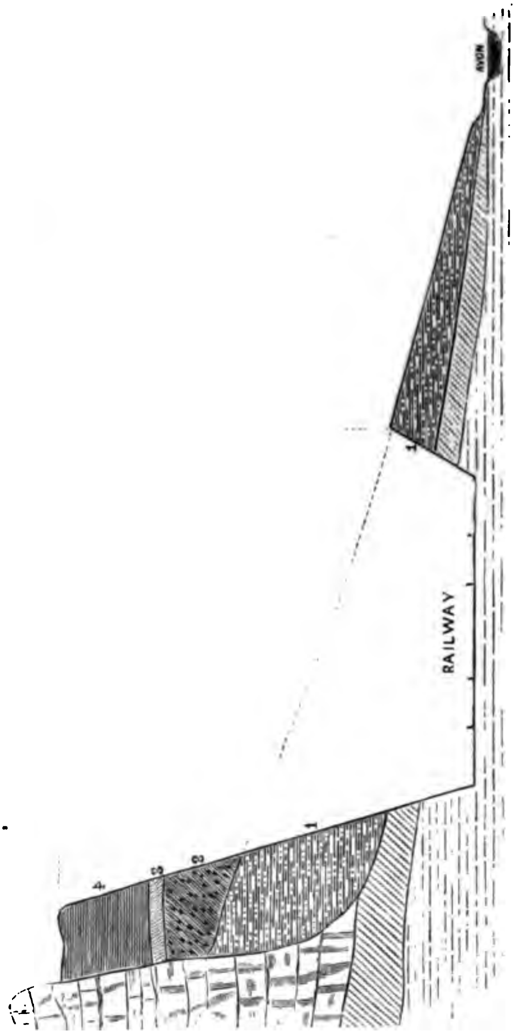


FIG. 75.—Section of Valley-gravels at Freshford, Bath.
4, Red loam, 5ft. 6in.; 3, Oolitic wash, 1ft.; 2, Clay with flints, 4ft. 10in.; 1, Gravel with fossil mammals, 8ft.

surface soil, and sometimes at considerable depths. It is, therefore, of prehistoric and historic age, and since

it is found only in the valley bottoms, we may conclude that the present courses of the rivers along the sides of which it is found date back from the prehistoric age; while their ancient courses are marked by the fluviatile deposits with the extinct mammalia standing at various levels, the higher being the older. In the section at Fisherton we have evidence that the river flowed at a lower level in the pleistocene age than in the prehistoric, and in that at Freshford that the lower portion of the valley had been excavated after the pleistocene strata had been formed. One or other of these physical changes is to be traced in nearly all river valleys.[1] We may conclude that both imply a considerable lapse of time, because similar changes are now produced with extreme slowness. In the pleistocene river deposits, which lie scattered about at various heights on the valley sides, we seek in vain for neolithic implements, or domestic animals. In the low-lying alluvia, and accumulations of peat, we seek equally in vain for traces of palæolithic man, or of the extinct mammalia, except the Irish elk.

We may also gather, from the localization of the prehistoric alluvia close to the present streams, that the time represented by its accumulation is insignificant in comparison with the long lapse of ages implied by the pleistocene gravels and brickearths, that were deposited at various heights during the excavation of the valleys. The general surface of the valleys has undergone but little change since history began, and the excavation by the rivers has been so small as to have escaped accurate measurement. The alluvia represent

[1] See Prestwich, "Phil. Trans." 1860, p. 277, and 1864, p. 247, and "Quart. Geol. Journ." *passim* 1859–70.

the principal work done since the close of the pleistocene period.

The most important testimony that the interval between the two periods was very long, is offered by the climatal change, and the severance of Britain from the continent. The arctic severity of the pleistocene winter in these latitudes had passed away before the prehistoric age, and the pleistocene valleys of the North Sea, St. George's Channel, the British, and Irish Channels had been depressed beneath the waves of the sea before any prehistoric strata yet known had been deposited. The evidence that these changes actually took place must be referred to the two following chapters.

Comparison of Deposits in Valleys with those in Caves.

If these valley deposits be compared with the contents of some of the bone caves, such, for example, as those of the Victoria Cave (compare Figs. 74 and 75 with Figs. 20, 21, 29), it will be seen that they present the same section. The pleistocene gravels and brick-earths of the one correspond with the lower strata of the other, and contain the same extinct animals. The prehistoric alluvium of the one is represented by the layer containing neolithic bronze or iron implements, as well as the same animals; while the historic strata are represented in both by the superficial accumulations. The only difference indeed between the one and the other is, that in the former the strata of the three periods are spread over a wide area, while in the latter they are super-imposed in vertical order, the pleistocene below, the prehistoric in the middle, and the historic on the surface.

Difference in Mineral Condition of Deposits in Caves.

The prehistoric, and the historic strata in caves differ from the pleistocene in their physical constitution. They are darker in colour, and more loosely stratified, and contain bones in a more friable and less mineralized condition, and are more free from stalagmite.

The Caves of Germany: Gailenreuth.

The use of fossil bones for medicinal purposes led, as I have already mentioned in the first chapter, to the exploration of caves, which were first scientifically examined in Germany towards the close of the eighteenth century. They abound in all the limestone plateaux, especially in the region of Franconia, and in that of the Hartz. Among them the most interesting, perhaps, is that of Gailenreuth, explored by Esper, Rosenmüller, Goldfuss, Buckland, Lord Enniskillen, and Sir Philip Egerton. It penetrates a lofty cliff, that forms a side of the deep gorge which the river Weissent has cut in the rock, at a point about three hundred feet above the water level.

The entrance, Dr. Buckland[1] writes, is about seven feet high and twelve feet broad, and within it a short passage leads into two chambers (Fig. 76, A and B),[2] hung with stalactites, and with the floors covered by a dense stalagmitic pavement, that has been more or less broken up by repeated diggings. These floors are perfectly

[1] "Reliquiæ Diluvianæ." 4to. 1824, p. 133.

[2] I am indebted to Lord Enniskillen, who explored Gailenreuth along with Sir Philip Egerton, for several corrections in Buckland's section.

horizontal, the level of that of B being considerably below that of A. They rest on an accumulation of reddish grey loam, containing pebbles, and angular limestone blocks, and vast quantities of the bones and teeth of the animals formerly living in the district. The depth of this ossiferous deposit has not been ascertained,

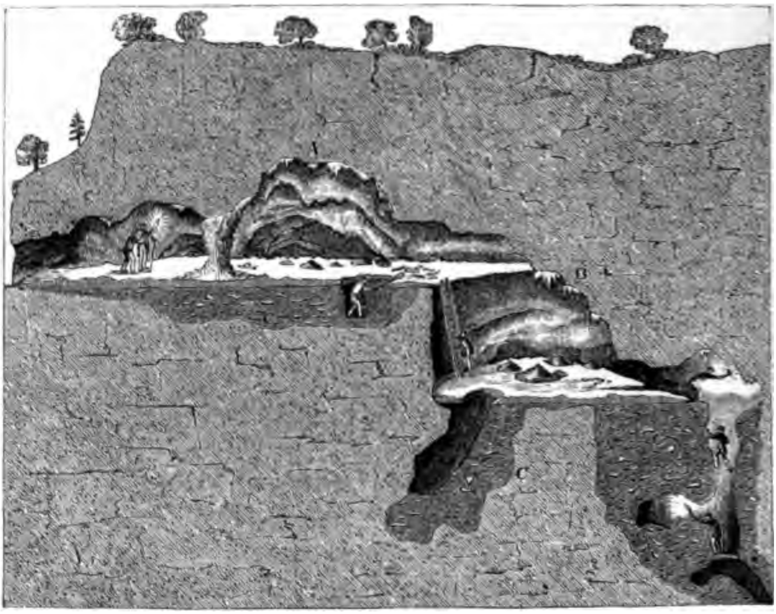


FIG. 76.—Section of Gailenreuth Cave. (Buckland.)

but in the further end of the chamber B, it has been proved to be more than twenty-five feet thick.

The remains of the animals lie scattered in the wildest confusion; sometimes being completely matted together, but more generally each bone is enveloped in earth. They belong to the lion, the cave variety of the spotted hyæna, the cave-bear, grizzly bear, mammoth, Irish elk, and reindeer, as well as to those species which are still

to be found in Germany, such as the glutton, brown bear, wolf, fox, and stag.

It is very difficult to account for such an accumulation as this, but it was probably introduced through the present entrance, and thence into the chamber B, passing from the higher to the lower levels. The teeth-marks on the bones show that some of the animals had formed the prey of the hyænas, but had they introduced all the bones there would have been distinct strata marking the floors of occupation, as in Wookey Hole (Fig. 88). Moreover, no perfect skulls, such as those of the bears, would have escaped their powerful teeth. The pebbles in the loam bear testimony to the passage of a current of water. And if we suppose that the cave was subject to floods, such as those in the water-caves described in the second chapter, the scattering of the bones through the loam may be explained. This, however, could not have happened had the cave then opened on the face of a nearly vertical cliff, and the only condition under which it would have been possible are, that the present entrance should have been directly connected with a stream flowing from the surface, that is to say, over the space now occupied by the gorge of the Weissent. If this view, advanced by Dr. Buckland, be accepted, the remoteness of the date of the filling up of the cave may be measured by the fact, that since that time the gorge has been cut down by the Weissent to a depth of more than 300 feet.

The stream by which the contents of the cave were introduced had a course probably analogous to that of Dalebeck (Fig. 6) and the remains of the animals were caught up from the surface, and accumulated in the

subterranean chambers which it traversed. Their abundance offers no obstacle to this view, since wild animals frequent their drinking places in vast numbers, and fall a prey to the carnivora which lurk near the streams, and very many tumble into the natural pitfalls, or swallow-holes, so universal in limestone districts.

The Cave of Kühloch.

Very many other caves occur in the neighbourhood, most of them, such as those of Zahnloch, celebrated for the abundance of fossil teeth, Mokas, Rabenstein, and others, of which the cave of Kühloch alone demands notice.

The cave of Kühloch is situated opposite to the castle of Rabenstein, in the gorge of the Esbach, at about thirty feet from the bottom. Its exterior presents a lofty arch in a nearly perpendicular cliff, about thirty feet wide and twenty feet high, and the entrance gradually leads into two large chambers " both of which terminate in a close round end, or cul-de-sac, at the distance of about 100 feet from the entrance. It is intersected by no fissures, and has no lateral communications connecting it with any other caverns, except one small hole close to its mouth, and which opens also to the valley." The first thirty feet present a steep slope towards the entrance. Dr. Buckland describes the contents of the chambers in the following words :[1]—

" It is literally true that in this single cavern (the size and proportions of which are nearly equal to those of the interior of a large church) there are hundreds of cart-loads of black animal dust entirely covering the

[1] Op. cit. p. 137.

whole floor, to a depth which must average at least six feet, and which, if we multiply this depth by the length and breadth of the cavern, will be found to exceed 5,000 cubic feet. The whole of this mass has been again and again dug over in search of teeth and bones, which it still contains abundantly, though in broken fragments. The state of these is very different from that of the bones we find in any of the other caverns, being of a black, or, more properly speaking, dark umber colour throughout, like the bones of mummies, and many of them readily crumbling under the finger into a soft dark powder resembling mummy powder, and being of the same nature with the black earth in which they are embedded. The quantity of animal matter accumulated on this floor is the most surprising, and the only thing of the kind I ever witnessed; and many hundred—I may say thousand—individuals must have contributed their remains to make up this appalling mass of the dust of death. It seems in great part to be derived from comminuted and pulverized bone; for the fleshy parts of animal bodies produce by their decomposition so small a quantity of permanent earthy residuum, that we must seek for the origin of this mass principally in decayed bones. The cave is so dry, that the black earth lies in the state of loose powder, and rises in dust under the feet; it also retains so large a proportion of its original animal matter that it is occasionally used by the peasants as an enriching manure for the adjacent meadows. I have stated that the total quantity of animal matter that lies within this cavern cannot be computed at less than 5,000 cubic feet; now allowing two cubic feet of dust and bones for each individual animal, we shall have in this single vault the remains of at least 2,500 bears, a number

which may have been supplied in the space of 1,000 years by a mortality at the rate of two and a half per annum."

Dr. Buckland's explanation, that the cave was inhabited by bears for long generations, is probably true. The absence of pebbles and silt show that water had no share in the introduction of the remains; their preservation is due to the dryness of the cave, and to its proximity to the outer atmosphere.

The famous caves of Sundwig, Schartsfeld, and Bauman's Hole, belong to the same class as Gailenreuth, and offer no differences which need be described.

These explorations establish the fact that, in the antediluvian age which we now term pleistocene, the lion, the cave-bear and grizzly bear, and cave-hyæna abounded in Germany, and that they sought as their prey not merely the wild animals now living in that region, but the reindeer, mammoth, woolly rhinoceros, and Irish elk. All the discoveries in the German caves from the date of the exploration of Gailenreuth have merely verified this conclusion without adding any new fact of importance.

The Caves of Great Britain.

These discoveries in the German caves led to the exploration of those in our country. Dr. Buckland visited Gailenreuth in 1816, and in 1821 applied the result of his knowledge gained in Germany to the investigation of the famous cavern of Kirkdale.[1]

[1] Op. cit. p. 1. *et seq.*

The Hyæna-den at Kirkdale.

The cave of Kirkdale (Figs. 77, 78) was discovered in a quarry in the vale of Pickering, about twenty-five miles to the NN.E. of York, at a point where the dale of Holmbeck joins Kirkdale. The entrance, eighty feet above the valley bottom and twenty feet from the surface

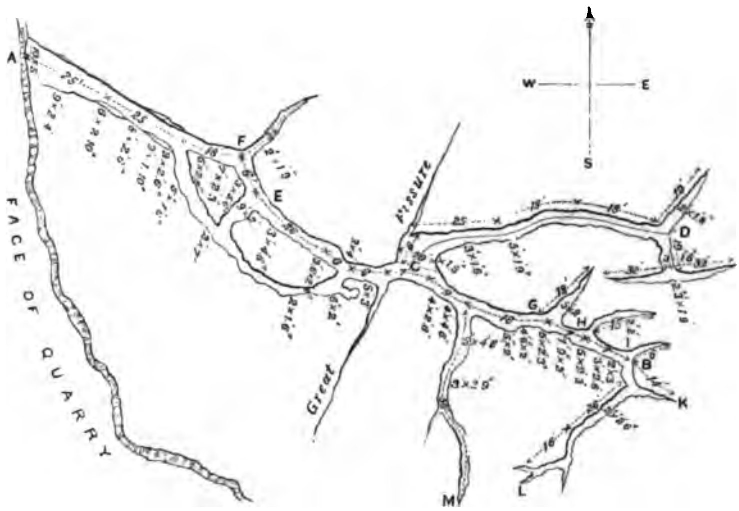


FIG. 77.—Plan of Kirkdale Cave. (Taylor.)

of the plateau above, was about three feet high and six feet wide, and led into a passage from five to ten feet wide, which ran nearly horizontally into the rock, and branched off into smaller ramifications. Its general form and size may be gathered from the examination of the accompanying woodcuts, which were published by Mr. Taylor in "Macmillan's Magazine," in September 1862. The roof was for the most part free from stalactite, and there was no continuous coating of stalagmite on the

floor, but merely here and there a few calcareous bosses termed "cows' paps" by the workmen.

A layer of fine red loam covered the bottom, in the lower portions of which were large numbers of gnawed and broken bones, and teeth, for the most part of the same species as those formed in the German caves. In some places they were lying in little confused heaps, and in others, where the loam was thin, were exposed to the calcareous drip and cemented into a mass, their

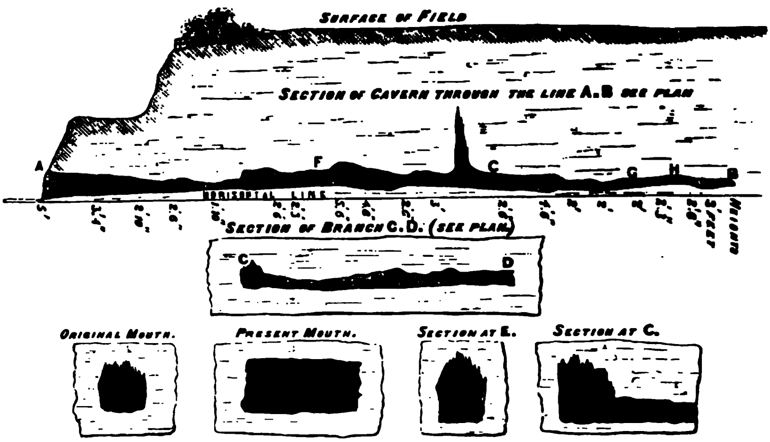


FIG. 78.—Sections of Kirkdale Cave. (Taylor.)

upper portions projecting through the stalagmite "like the legs of pigeons through pie-crust," and their irregular distribution resembling that of the fragments scattered on the floor of a dog-kennel.

The remains of the animals were incredibly abundant, when the small space in which they were packed was taken into consideration. Those of the hyæna are estimated by Dr. Buckland as belonging to between two or three hundred individuals of all ages. The lion and the

cave-bear, the wild boar, the hippopotamus (Fig. 79) an extinct kind of elephant (*E. antiquus*), and the rhinoceros named by Dr. Falconer *R. hemitœchus*, the reindeer, and Irish elk are also represented, but the species of most common occurrence are the bison and the horse. With a few exceptions all the bones with marrow were broken, and scarred by teeth, while the solid and marrowless were more or less perfect.

Dr. Buckland's method of solving the problem of the introduction of remains of so many and different animals into so small a space, is a model of scientific analysis. He argues from the abundance of the remains of the hyæna, and from the correspondence of their teeth with the marks on the bones, and from the quantity of their coprolites, that the cave was inhabited by many generations of those animals, and that the gnawed fragments were relics of their prey. The hyænas of the present day inhabit caves strewn with the bones of their prey, which are crushed by their powerful jaws into the same form as those of Kirkdale. He further demonstrated the truth of his conclusion by the crucial experiment of subjecting the leg-bone of an ox to a spotted hyæna from the Cape of Good Hope, in Wombwell's Menagerie. "I was able," he writes,[1] "to observe the animal's mode of proceeding in the destruction of bones: the shin-bone of an ox being presented to this hyæna, he began to bite off with his molar teeth large

FIG. 79.—Molar of Hippotamus. (Buckland.)

[1] Op. cit. p. 38.

fragments from its upper extremity, and swallowed them whole as fast as they were broken off. On his reaching the medullary cavity, the bone split into angular fragments, many of which he caught up greedily and swallowed entire: he went on cracking it till he had extracted all the marrow, licking out the lowest portion

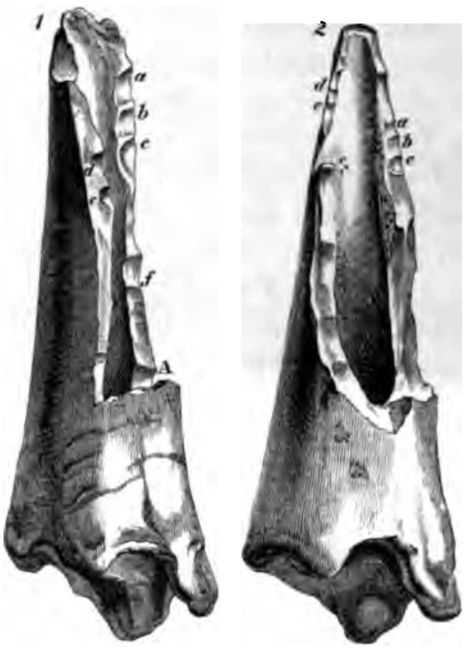


FIG. 80. Leg-bones gnawed by Hyænas—1, of Ox in Menagerie; 2, of Bison in Kirkdale. (Buckland.)

of it with his tongue: this done, he left untouched the lower condyle, which contains no marrow, and is very hard. The state and form of this residuary fragment are precisely like those of similar bones at Kirkdale; the marks of teeth on it are very few, as the bone usually gave off a splinter before the large conical teeth had forced a hole through it: these few, however, entirely

resemble the impressions we find on the bones at Kirkdale; the small splinters also in form and size, and manner of fracture, are not distinguishable from the fossil ones. I preserve all the fragments and the gnawed portions of this bone, for the sake of comparison by the side of those I have from the antediluvian den in Yorkshire: there is absolutely no difference between them, except in point of age. The animal left untouched the solid bones of the tarsus and carpus, and such parts of the cylindrical bones as we find untouched at Kirkdale, and devoured only the parts analogous to those which are there deficient. The keeper, pursuing this experiment to its final result, presented me the next morning with a large quantity of *album græcum*, disposed in balls, that agree entirely in size, shape, and substance with those that were found in the den at Kirkdale. The power of his jaws far exceeded any animal force of the kind I ever saw exerted, and reminded me of nothing so much as of a miner's crushing mill, or the scissors with which they cut off bars of iron and copper in the metal foundries."

The exact correspondence of one of the fragments of the tibia of an ox, gnawed by the Cape hyæna, with the corresponding bone of the bison from Kirkdale, may be gathered from a comparison of the two figured in Fig. 80, in which the teeth-marks *a*, *b*, and *c*, are very distinct. The same kind of identity runs through the whole series of bones gnawed by the living and fossil hyænas.

Dr. Buckland's conclusion, that the Kirkdale cave was the den of the spotted hyænas (*H. crouta*) that preyed upon the animals of Yorkshire in ancient times, and that it was undisturbed down to the time of its explora-

tion, cannot be disputed. The tread of the hyænas in their passage to and fro had polished some of the bones and jaws scattered on the floor, and the polished surfaces were uppermost, the rest of the fragments being rough. And Prof. Phillips informs me that the leg-bone of a ruminant was discovered wedged into a small fissure in the floor, with that portion which was within reach of the hyæna's teeth gnawed away, while the rest was uninjured. The hyæna had lost his bone in the fissure, and was only able to nibble the end which projected. In these incidents we have a vivid picture of an hyæna's den in Yorkshire during the pleistocene age, with the contents left in their natural order and not rearranged by the passage of water.

The Victoria cave near Settle, in Yorkshire, described in the third chapter, has also been occupied by hyænas.

Caves of Derbyshire: the Dream-cave near Wirksworth.

The Dream-cave, near Wirksworth,[1] in Derbyshire, contrasts with that of Kirkdale in the perfect state of the bones which it contains. It was discovered in 1822, in following a vein of lead (Fig. 81). The miners suddenly broke into a hollow, *c*, filled with red earth and stones, and as they continued their shaft downwards the sides continually closed upon them until the roof of a cave was revealed. A nearly perfect skeleton of the rhinoceros was discovered in the earth, as well as bones of the horse, reindeer, and urus. After a large quantity of the earth had been removed, the surface soil, *i*, at a little distance began to sink, and ultimately a vertical shaft

[1] Buckland, op. cit. p. 61.

was found to connect the cave with the surface. Into this the animals had fallen, just as at the present time sheep and oxen frequently perish in similar natural pitfalls in the limestone strata.

Other caves and fissures in Derbyshire have yielded remains of the extinct animals: those of Balleye, near

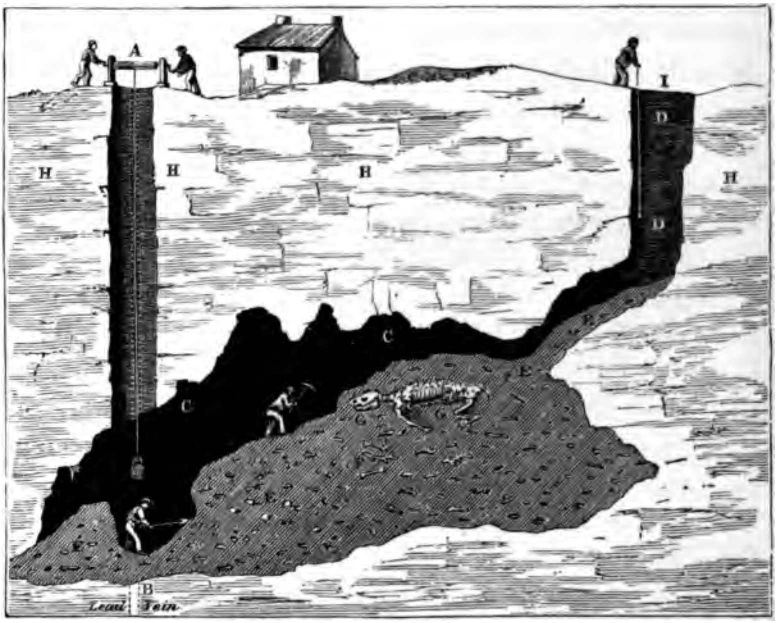


FIG. 81.—The Dream-cave, Wirksworth. (Buckland.)

A Shaft following lead-vein.
B Supposed continuation of lead-vein.
C Cave.
D Swallow-hole.
E Ossiferous loam.
F Antler of deer.
G Rhinoceros.
H Limestone.
I Natural entrance.

Wirksworth, and of Doveholes, near Chaple-en-le-Frith, the mammoth, and a small cave in Hartle Dale, near Castleton, explored by Mr. Pennington and myself in 1872, the mammoth and the woolly rhinoceros.

The Caves of North Wales, near St. Asaph.

The ossiferous caves and fissures at Cefn, near St. Asaph, in the mountain limestone that forms the south side of the Vale of Clwyd, were first described in 1833,[1] by the Rev. Edward Stanley, afterwards Bishop of Norwich, who explored that which Mr. E. Lloyd had discovered about half-way down the vertical cliff, in the grounds of Cefn Hall. It consists of a narrow passage, turning on itself, and communicating with the surface of the cliff by two entrances, which were completely blocked up with red silt, containing a vast quantity of bones in very bad preservation. The bottom has not yet been reached. In one portion I found, in 1872, a deposit of comminuted bone with scarcely any mixture of loam, that rose in clouds of dust as it was disturbed. The animals belonged to the same class as those of Germany, the cave-bear, spotted hyæna, and reindeer, as well as the hippopotamus, *Elephas antiquus* and *Rhinoceros hemitœchus* of the Kirkdale cave. Pebbles derived from the boulder clay, and rounded waterworn fragments of bone, showed that the contents had been introduced into this cave by a stream. Some of the remains, which were marked with teeth, may have been introduced by the hyænas. The flint-flakes found with the human skull and cut antlers of stag, already referred to in the fifth chapter, were discovered in the lower entrance.

The same group of animals has been obtained by Mrs. Williams Wynn, the Rev. D. R. Thomas, and myself out of a horizontal cave at the head of the defile leading

[1] "Edinburgh New Phil. Soc." No. 27, p. 40. Falconer, "Palæont. Mem." ii. p. 541. I have examined nearly all the contents of these caves.

down from Cefn to Pont Newydd, in which the remains are embedded in a stiff clay, consisting of rearranged boulder clay, and are in the condition of waterworn pebbles. From it I have identified the brown, grizzly, and cave-bear. A further examination by the Rev. D. R. Thomas, and Prof. Hughes, has recently resulted in the discovery of rude implements of felstone, and a tooth which has been identified by Prof. Busk as a human molar of unusual size.[1]

FIG. 82.—Left Lower Jaw of Glutton, Plas Heaton Cave.

A third cave in the neighbourhood at Plas Heaton, explored in 1870 by Mr. Heaton and Prof. Hughes, furnished the remains of the cave-bear, spotted hyæna, bison, and reindeer, and a remarkably fine specimen of the lower jaw of a glutton (Fig. 82), which I have described in the "Geological Journal" (vol. xxvii. p. 406). In a fourth cave, at Galtfaenan, the bear and reindeer were discovered. It is evident from the presence of numerous bones gnawed by hyænas in these caves, that the valleys of the Clwyd and the Elwy were the favourite haunts of that animal in the pleistocene age.

[1] Anthrop. Institute Meeting, 9 Dec. 1873.

Caves of South Wales in the counties of Glamorgan and Caermarthen.

The earliest cavern explored in South Wales is that of Crawley Rocks,[1] Oxwich Bay, about twelve miles from Swansea. It was discovered in quarrying the mountain limestone in 1792, and contained the remains of the elephant, rhinoceros, ox, stag, and hyæna. It was completely destroyed before Dr. Buckland identified these animals in the collection of Miss Talbot of Penrice Castle.[2]

The line of cliffs, bounding the rocky peninsula of Gower, contains the cave of Paviland, described in the seventh chapter (p. 232), as well as the group explored by Colonel Wood of Start Hall, from the year 1848[3] to the present time, Bacon Hole, Minchin Hole, Bosco's Den, Devil's Hole, Crow Hole, Raven's Cliff, Spritsail Tor, and Long Hole, which are described by the late Dr. Falconer. The *Rhinoceros hemitœchus* was met with in comparative abundance, and in association with the woolly rhinoceros, mammoth, and *E. antiquus*. In Bosco's Den there were no less than 750 shed antlers of reindeer; and in Long Hole, many flint-flakes were discovered in 1860 underneath the stalagmite, and in association with the extinct mammalia, which prove, as Dr. Falconer points out, that man inhabited that district in the pleistocene age.

These caves and fissures were at all levels in the cliff, and in some the bottoms were covered with a stratum of marine sand with sea shells, which showed that they had been washed by the sea before they had been filled by the ossiferous débris. Most of them had probably

[1] Buckland, op. cit. 80. [2] Op. cit. p. 80.
[3] Falconer "Palæont. Mem." ii. 498.

been filled by streams in the same manner as Gailenreuth and Wirksworth. They abound on the coast merely because a clear section has been worn by the waves. A straight cut through the rocks in any part of the district would probably show them to occur in equal abundance inland.

Caves in Pembrokeshire.

The patches of limestone on the opposite side of Caermarthen Bay, in the neighbourhood of Tenby, also contain ossiferous caverns. The Rev. G. N. Smith,[1] of Gumfriston, has made a fine collection of bones and teeth of mammoth and hyæna, from a fissure in the Blackrock Quarry, close to Tenby, from a fissure in the cliff on Caldy Island, and from the Coygan cave in an outlier of limestone, near Pendine, and has discovered flakes of flint and of a peculiar hornstone in the "tunnel cave" termed the Hoyle, underneath stalagmite, in a stratum containing bones of the bear and reindeer. With the exception of the fissure in the Blackrock Quarry none of these have been fully explored. On a visit to Tenby, in 1872, I obtained many flint flakes, and bones broken by man, from the breccia in the Hoyle; and from a fissure on Caldy Island, numerous bones and teeth of young wolves, which represented a whole litter, and two metatarsals of bison, cemented together into a compact mass.

The discovery of mammoth, rhinoceros, horse, Irish elk, bison, wolf, lion, and bear, on so small an island as Caldy, indicates that a considerable change has taken

[1] "On the Tenby Bone Caves," by a Pembrokeshire Rector. London: Kent and Co.

place in the relation of the land to the sea in that district since those animals were alive. It would have been impossible for so many and so large animals to have obtained food on so small an island. It may therefore be reasonably concluded that, when they perished in the fissures, Caldy was not an island, but a precipitous hill, overlooking the broad valley now covered by the waters of the Bristol Channel, but then affording abundant pasture. The same inference may also be drawn from the vast numbers of animals found in the Gower caves, which could not have been supported by the scant herbage of the limestone hills of that district. We must, therefore, picture to ourselves a fertile plain occupying the whole of the Bristol Channel, and supporting herds of reindeer, horses, and bisons, many elephants and rhinoceroses, and now and then being traversed by a stray hippopotamus, which would afford abundant prey to the lions, bears, and hyænas inhabiting all the accessible caves, as well as to their great enemy and destroyer man. We shall see in the ninth chapter that the elevation of the whole district above its present level is part of the general elevation of north-western Europe, and no mere small or local phenomenon.

Cave in Monmouthshire.

King Arthur's cave,[1] on the side of a beautifully wooded knoll, overlooking the valley of the Wye, near Whitchurch, in Monmouthshire, explored by the Rev. W. S. Symonds in 1871, is a hyæna den, like that of Kirkdale, containing the gnawed remains of the lion,

[1] See "Brit. Assoc. Rep." 1871. "Geol. Mag." viii. 433.

Irish elk, mammoth, woolly rhinoceros, and reindeer. Flint flakes, however, occurred in the undisturbed strata, which prove that it was also the resort of man. Mr. Symonds believes that the sand and gravel inside were deposited by the Wye, at a time when it flowed 300 feet above its present course, or before the valley was cut down to that depth. If this conclusion be true, the date of the occupation must be separated from the present day by a vast interval, which is only to be measured by the subsequent erosion of the valley by the slow operation of the subaerial agents, running water, ice, snow, and carbonic acid.

The only remains of the mammoth which I have examined belong to young individuals, and consist of the second and third milk-molars, a fact which I have very generally observed in hyænas' dens. The older mammoths would not fall an easy prey to so cowardly an animal. The cave had also been inhabited by man after the pleistocene age, for coarse pottery of the neolithic kind, and flint flakes, were dug out of an upper stratum, while I was watching the excavation, in company with the Rev. W. S. Symonds, and the "Wanderers" field club.

Caves of Gloucestershire and Somersetshire.

The outliers of mountain limestone, on the southern side of the Bristol Channel, have long been known for their ossiferous caverns and fissures. From a fissure in Durdham Down,[1] near Bristol, Mr. J. S. Miller obtained fragments of bones, about the year 1820, and among them Dr. Buckland notices the fossil joint of the hind-leg of a horse, the astragalus being held in natural position,

[1] Buckland, *op. cit.* p. 60.

between the tibia and the calcaneum, by stalagmite. Subsequently a large series of animals of the same species as those of Gower were discovered in it by Mr. Stutchbury, and are preserved in the Bristol Museum.

Caves of the Mendip Hills.

The caves of the Mendip Hills were known to contain bones as early as the middle of the eighteenth century, when that of Hutton,[1] near Weston-super-Mare, was discovered in working the ochre and calamine which fills some of the fissures. The miners having opened an ochre pit, south of the little village of Hutton, discovered a fissure in the limestone full of good ochre, which they followed to a depth of eight yards, until it led into a cavern, the floor of which was formed of ochre, with large quantities of white bones on the surface, and scattered through its mass. Dr. Calcott describes the bones as projecting from the sides, roof, and floor of the excavation in such quantities as to resemble the contents of a charnel-house. Subsequently it was fully explored by the Rev. D. Williams, and Mr. Beard, of Banwell.

We owe the exploration of the neighbouring caves of Banwell, Sandford Hill, Bleadon, Goat's Hole, in Burrington Combe, and Uphill,[2] to the joint labours of the two above-mentioned gentlemen, extending over the period which elapsed between 1821 and 1860. The vast quantity of remains which they obtained can only be realized by a visit to the Museum of the Somerset Archæological and Natural History Society, at Taunton.[3]

[1] Buckland, *op. cit.* Rutter, "Delineations of Somerset," p. 100.

[2] See Buckland, *op. cit.* Rutter, *op. cit.*

[3] See "Catalogue of Mammalia, in Taunton Museum," by W. A. Sanford, Esq. Som. Archæol. Soc.

They belong to the same species as those already mentioned from the caves of South Wales. The fauna of the Mendip is, however, characterized by the great number of lions, and by a few fragments of the glutton. Of the former animal, Mr. Ayshford Sanford and myself have met with sufficient remains to figure nearly every portion of the skeleton, and the skulls prove that it was not a tiger, as it is considered to be by some naturalists, but a true lion, differing in no respect, except in its large size, from those now living in Asia and Africa.

All these caverns consist of chambers at various levels more or less connected with fissures, and, from the perfect condition of the bones they must have been inaccessible to the bone-destroying hyæna. Their contents were introduced, as is suggested by Dr. Buckland, from the surface by streams falling into swallow-holes (see Fig. 81), which have now, under the changed physical conditions, ceased to flow.

The extraordinary quantity of remains preserved in one cave may be, to some extent, verified by a visit to that at Banwell. It consists of two large chambers, the upper one filled with thousands of bones of bison, horse, and reindeer, taken out of the red silt which originally filled it to the roof; the lower one full of the undisturbed contents, from which the bones project in the wildest confusion. This accumulation has been introduced by water, through a vertical fissure which opened on the surface. It is evident, from the very nearly perfect skulls of wolf and bear which were discovered, that the cave was not used as a den by the hyænas. They are, however, proved to have been living close by at the time, since their skulls, and the gnawed antlers of reindeer, have been discovered

inside. They were probably swept in by the stream along with the other bones.

The Uphill Cave.

The Cave of Uphill,[1] discovered in 1826, by some workmen, and explored by the Rev. D. Williams, merits especial notice, from the peculiar conditions under which the remains of the extinct animals occurred. Like the other caves of the Mendips, it consists of fissures opening into chambers. In the upper part of one of these fissures were the remains of rhinoceros, hyæna, bear, horse, bison, and wild boar, imbedded in loam which rested on two large masses of limestone that had fallen so as to block up the fissure. Below this were no remains of the extinct animals, and the fissure ultimately led into a cave opening upon the line of cliffs. This latter had been inhabited within historic times, since many bones of sheep, or goat, and pieces of pottery, were met with, as well as a coin of the Emperor Julian. In this case, owing to the extraordinary accident of the fissure being blocked up by a fall of stone, the pleistocene accumulation is vertically above the historic; and had the barrier given way, Mr. Williams would undoubtedly have discovered the remains of the extinct mammalia, lying in a heap above the comparatively modern historic stratum. It seems to me very probable that some such accident may have caused the occurrence of the pleiocene machairodus in the Kent's Hole cavern, in association with the pleistocene mammalia. In the long lapse of ages between the pleistocene and the present day, such accidents would be likely to occur in some

[1] Rutter gives a very good section of this cave (*op. cit.* p. 78).

few caverns, and we might expect to find remains of widely different ages, in certain exceptional cases, lying side by side, or even the older resting vertically over the newer. At all events we must conclude, that superposition, or association, cannot be rigidly enforced as tests of relative age in all ossiferous caverns.

The Hyæna-den of Wookey Hole.

The Hyæna-den of Wookey Hole,[1] near Wells, on the south side of the Mendips, which I explored with the Rev. J. Williamson in 1859, and in the following years with Messrs. Willett, Parker, and Ayshford Sanford, is worthy of a more detailed notice, because it was among the first caverns in this country in which works of art were found under conditions that proved the co-existence of man with the extinct mammalia.

The ravine in which it was discovered, in 1852, is one of the many which pierce the dolomitic conglomerate, or petrified sea-beach, of the Triassic age, resting at the foot of the cliffs from which it was torn by the waves, and overlying the lower slopes of the Mendips (see Fig. 1). Open to the south, it runs almost horizontally into the mountain-side, until closed abruptly northwards by a perpendicular wall of rock, 200 feet or more in height, ivy-covered, and affording a dwelling-place to innumerable jackdaws. Out of a cave at its base, in which Dr. Buckland discovered pottery and human teeth, flows the river Axe, in a canal cut in the rock. In cutting this passage, that the water might be conveyed to a large paper-mill close by, the mouth of the hyæna-

[1] "Quart. Geol. Journ." 1862: On a Hyæna-den at Wookey Hole. Also "Quart. Geol. Journ." 1863.

den was intersected in 1852, and from that time up to December 1859 it was undisturbed save by rabbits and badgers, and even they did not penetrate far into the interior, or make deep burrows. Close to the mouth of the cave the workmen (employed in making this canal) found more than 300 Roman coins, among which were those of Allectus and of Commodus. When the Rev. J. Williamson and myself began our exploration, about twelve feet of the entrance of the cave had been cut away, and large quantities of the earth, stones, and animal remains had been used in the formation of an embankment for the stream which runs past the present entrance of the cave.

According to the testimony of the workmen, the bones and teeth formed a layer about twelve inches in thickness, which rested immediately upon the conglomerate-floor, while they were comparatively scarce in the overlying mass of stones and red earth. The workmen state also that at the time of the discovery of the cave the hill-side presented no concavity to mark its presence. So completely was the cave filled with débris up to the very roof, that we were compelled to cut our way into it. Of the stones scattered irregularly through the matrix of red earth, some were angular, others water-worn; all are derived from the decomposition of the dolomitic conglomerate in which the cave is hollowed. Near the entrance, and at a depth of five feet from the roof, were three layers of peroxide of manganese, full of bony splinters, and, passing obliquely up towards the southern side of the cave and over a ledge of rock that rises abruptly from the floor: further inwards they became interblended one with another, and at a distance of fifteen feet from the entrance were barely visible. In

and between these the animal remains were found in the greatest abundance.

While cutting our way inwards (Figs. 83 and 88), we found an angular piece of flint, which had evidently been

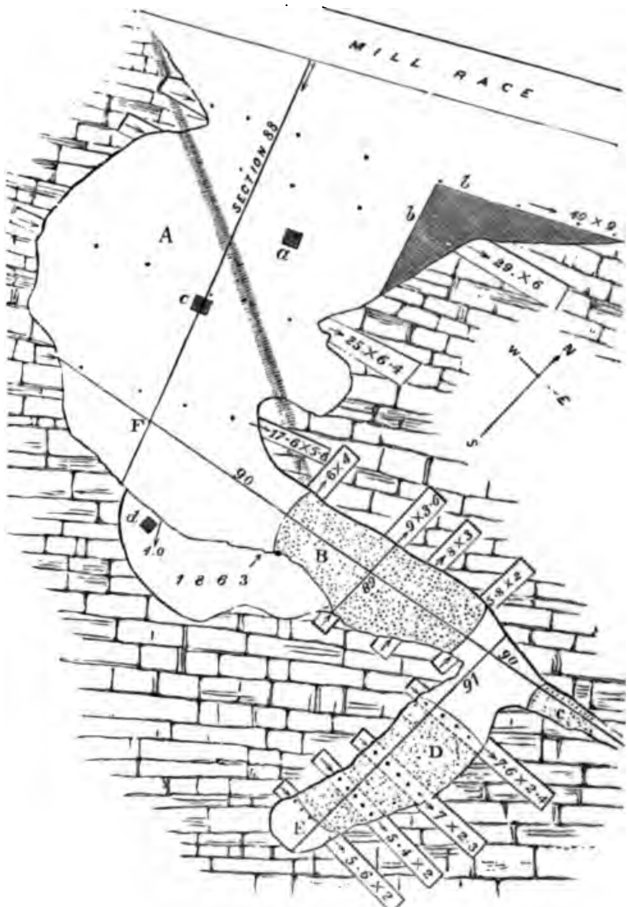


FIG. 83.—Plan of Hyæna-den at Wookey Hole.
Right lines = sections; dotted areas = bone-beds; shaded areas = ashes and implements.

chipped by human agency, and a water-worn fragment of a belemnite, which probably had been derived from

the neighbouring marlstone rocks. Bones and teeth of the woolly rhinoceros, reindeer, stag, Irish elk, mammoth, hyæna, cave-bear, lion, wolf, fox, and horse rewarded our labours; and frogs' remains, cemented together by stalagmite, were abundant at the mouth. The teeth preponderated greatly over the bones, and the great bulk were those of the horse. The hyæna-teeth also were very numerous, and in all stages of growth, from the young unworn to the old tooth worn down to the very gums. Those of the mammoth had belonged to a young animal, and one had not been used at all. The hollow bones were completely smashed and splintered, and scored with tooth-marks, while the solid carpal, tarsal, and sesamoid bones were uninjured, as in the Kirkdale Cave. The organic remains were in all stages of decay, some crumbling to dust at the touch, while others were perfectly preserved and had lost very little of their gelatine.

In 1860 we resumed our excavations; and, in addition to the above remains, found satisfactory evidence of the former presence of man in the cave. Our search was rewarded by one oval implement of white flint, of rude workmanship (Figs. 84, 85, 86, 87), one chert arrow-head, a roughly-chipped and a round flattened piece of chert, together with various splinters of flint, which had apparently been knocked off in the manufacture of some implement. Two rudely-fashioned bone arrow-heads were also found, which unfortunately were subsequently lost by the photographer to whom they were sent; they resembled in shape an equilateral triangle with the angles at the base bevelled off. All were found in and around the same spot, in contact with some hyæna-teeth, between the dark bands of

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87

Figs. 84, 85, 86, 87.—Four Views of Flint Implements found in the Hyæna-den at Wookey Hole, near Wells.

manganese, at a depth of four feet from the roof, and at a distance of twelve feet from the present entrance (Fig. 83, *a*).

That there might be no mistake about the accuracy of the observations, I examined every shovelful of débris as it was thrown out by the workman; while the exact spot where they were excavating was watched by my colleague. The figured implement was picked out of the undisturbed matrix by him; the rest were found by me in the earth thrown out from the same place.

The lines of peroxide of manganese must have been accumulated on the old floors of the cave, because they were associated with numerous splinters and gnawed animal remains; and there can be no doubt that the latter were introduced by the hyænas. Those animals have a peculiar habit, as Dr. Buckland proved by experiment, of gnawing similar bones in precisely the same way; and a comparison of the relics of the meals of the hyænas in the Zoological Gardens with those in the cave, shows that the latter have passed between the jaws of a like animal that once inhabited Somersetshire. Coprolites of the same animal were very abundant, and in some places formed a greyish-white layer of phosphate of lime. There were also other equally unmistakeable traces of the animal in fragments of bone, polished by their tread, as in the Kirkdale cave. It is, therefore, only reasonable to suppose that these remains of animals were brought into the cave from time to time by hyænas, and left on the floors. That they were not introduced by water is proved by the preservation of the delicate processes and points of bone, which would certainly have been broken *in transitu*. Since, then, the implements, which, beyond doubt, had been fashioned by man, were

underneath one of these old floors, it was certain that man was contemporary in the district with the hyæna and the animals on which it preyed, and the fact that they were found only on one spot implies that they were deposited by the hand of man. To suppose that a savage would take the trouble to excavate a trench twenty-four feet long—for twelve feet of the former mouth of the cave had been cut away—with miserable implements, and consequently with great labour, and having excavated it again to fill it up to the very roof, is little less than absurd. Nor could such an operation take place in such a deposit, without the stratification of the layers being destroyed. The absence of pottery and human bones precludes the idea of the cave ever having been a place of sepulture, such as Aurignac or Bruniquel. This discovery, therefore, of itself stamps the contemporaneity of man with the extinct mammalia, and following close on the similar discoveries in Brixham cave, to be mentioned presently, puts the question beyond all doubt.

In April 1861 we resumed our excavations; and, as we made our way inwards, found that the cave began to narrow, and ultimately to bifurcate, one branch extending vertically upwards, while the other appeared to extend almost horizontally to the right hand. As we reached the middle constricted passage, the teeth became fewer, while the stones were of larger size than any that we had hitherto discovered. The great majority of the gnawed antlers of deer were found at this part, also the posterior half of a cervine skull, the right upper jaw of wolf, and, what is more remarkable, a stone with one of its surfaces coated with a deposit apparently of stalagmite: this, however, was much lighter than stalagmite, and not so good a conductor of heat; and, on analysis,

I found that it consisted of phosphate of lime, with a little carbonate, and a very small portion of peroxide of manganese. Doubtless the surface of the stone, covered with phosphate of lime, formed part of the ancient floor of the cave, and hence was coated with *album græcum*; while the lower part, being imbedded in the earth on the floor, was not so coated. This deposit may, perhaps, explain the absence of round balls of coprolite, which, assuming that the cave at the time was more damp than that at Kirkdale, would be trodden down on the floor by the hyænas, instead of presenting a rounded form. The stone also itself exhibits tooth-marks underneath the coating of *album græcum*, and probably was gnawed by the hyænas, like the antlers, for amusement. This discovery proves that violent watery action had but small share, if any, in filling the cave; for in that case the soft covering would have been removed from the stone. Similar evidence is offered by the wonderful preservation of some of the more delicate fragments of bone, such as the palatine process of the maxilla of the wolf.

The section made in cutting this passage presented irregular layers of peroxide of manganese, full of bony splinters, and each more or less covered by a layer of bones in various stages of decay. These layers were absent from the upper portion of the passage. There were masses of prisms of calc-spar scattered confusedly through the matrix. After excavating the vertical branch as far as we dared (for the large stones in it made the task dangerous), we were compelled to leave off, having penetrated altogether only thirty-four feet from the entrance. No flint implements rewarded our search this year. Teeth were far more numerous than

bones, probably because they are more durable as well as because of their rejection by the hyænas. One jaw was bitten in two, and the fragments found about a foot apart in the undisturbed matrix, just as they had been dropped from the mouth of the hyæna.

In the spring of 1862 Mr. Parker, Mr. Willett, and myself resolved to verify the association of articles of man's handiwork along with the extinct mammalia, by cleaning out the cave, which was courteously placed at our disposal by the owner, Mr. Hodgekinson.

Our first task was to clear the contents out of the portion of the cave nearest the mouth, or the antrum (Fig. 83, A), and as we excavated onwards many traces of the presence of man were met with. A wide area on the left-hand side (*b*), where the roof and floor of the cave gradually met together, furnished innumerable fragments of charcoal, and many flint implements associated with the remains of the horse, rhinoceros, and hyæna. One fragment of bone in particular, belonging to the rhinoceros, had been calcined, and its carbonized condition bore unmistakeable testimony that it had been burnt while the animal juices were present. There were many other bones also burnt, which indicated the place where fires had been kindled, and food cooked. As we dug our way forward we met with a third area (*c*), that furnished flint and chert implements under the same conditions of deposit as that which tempted us to carry on our excavations. Its relation to the old floors of hyæna-occupation is shown by the dark lines over the area *c* in Fig. 88. At last the large open chamber (A) was cleared; it measured about thirty feet wide by six feet high, and it extended forty feet inwards. On the left there was a small upward-turning passage, very nearly

blocked up with a mass of stalagmite; at the farther end a vertical fissure extended upwards (F), to the surface. This fissure has subsequently been proved to extend downwards to the right, and will doubtless furnish large quantities of animal remains to future explorers.

The large chamber now turned abruptly to the left, and we gradually worked our way into a small horizontal passage about four feet high. Here there was an

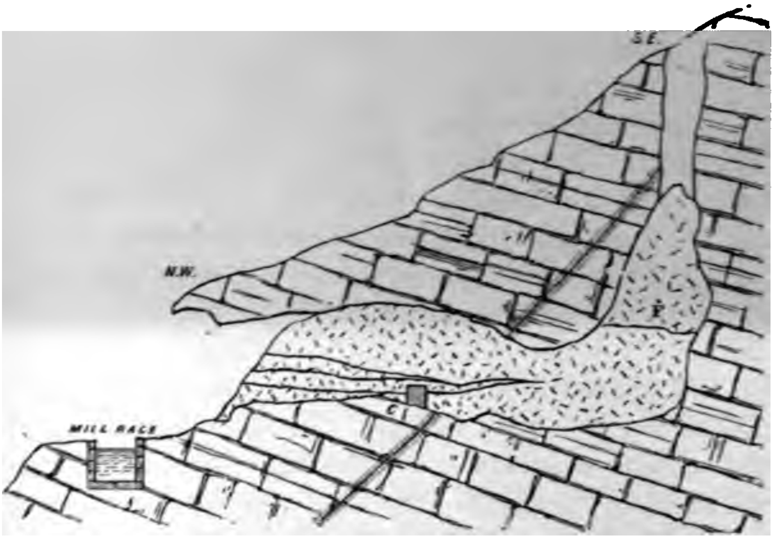


FIG. 88.—Section through A of Fig. 83, showing contents of Hyæna-den. c = flint implements; thick lines above = old floors.

interval of from three to four inches between the roof and contents, traversed by stalactites, which in some places formed a smooth undulating drapery with stony tassels, and in others tiny pillars extending down to the débris, and, as it were, propping up the roof. These pedestals (see Fig. 15) gradually expanded into round plates of stalagmite, which sometimes met and formed a continuous crust. In some places an infiltration of car-

bonate of lime had cemented organic remains, stones, and earth into a hard mass, which had to be broken up with gunpowder before it could be removed out of the cave. The excitement of extracting from these blocks their treasures was of the very keenest, for we could not tell what a stroke of the hammer would reveal. Sometimes an elephant's tooth suddenly came to light, at others a hyæna's jaw, or a rhinoceros' tooth, or the antler of a reindeer, or the canine of a bear. The bones were so numerous that they scarcely attracted attention. In one fragment of this breccia, now in the Brighton Museum, are a tusk and carpal of mammoth, the right

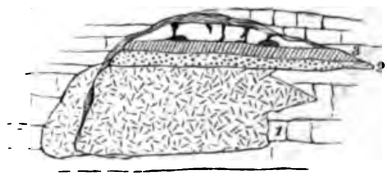


FIG. 89.—Transverse Section through B of Fig. 83.
1 = red earth ; 2 = bone-bed ; 3 = dark earth.

ulna of the woolly rhinoceros, and an antler of reindeer. In a second, two shoulder-blades and two haunch bones of the woolly rhinoceros, with a coprolite and lower jaw of cave hyæna. As the men removed the large blocks they were brought to the mouth of the cave to be broken up by our smaller instruments. Presently the passage narrowed to about six feet, and presented the following section (Fig. 89). On the floor of the cave there was a layer of red earth two feet in thickness, and, as usual, containing a few organic remains and many stones (Fig. 89, 1). Upon this rested a most remarkable accumulation of bones, and teeth, matted

and compacted together, from three to four inches thick, and extending horizontally from one side of the passage to the other (Fig. 89, 2). Next came a layer of dark red earth (Fig. 89, 3), loose and friable, three to four inches thick, supporting in its surface a few rounded stalagmites, and a few stalactitic pillars, that spanned the interval of from three to four inches between it and the roof. This bone-bed was about seven feet wide and fourteen feet long, affording, therefore, a square area of ninety-eight feet (see dotted area B Fig. 83, and in Fig. 90). The enormous quantity of the remains of animals present cannot fairly be estimated even by the large

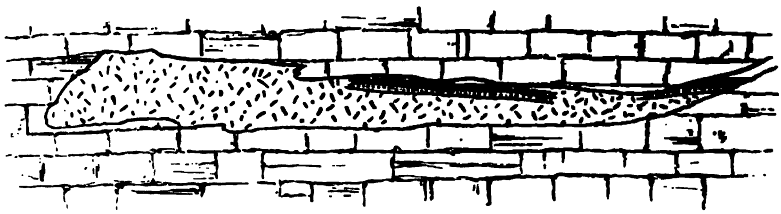


FIG. 90.—Longitudinal Section through B and C of Fig. 83, showing bone-beds. Dotted area = bone-bed.

number preserved, because most of the bones were as soft as wet mortar. The five hundred and fifty specimens obtained must be looked upon merely as a small fraction of the whole.

We presently passed beyond the bone-bed, and found that the passage bifurcated (Fig. 83, C and D), the smaller branch going straight forwards and gently upwards (Fig. 90), while the larger stretched at right angles from it and passed gently downwards. In the former there was a second bone-bed similar in every respect to that already described, which continued undiminished in thickness until it rested directly on

the floor. It afforded a square area of about fifteen feet. The passage was about sixteen inches high and three feet wide, and gradually narrowed until at a distance of twelve feet from the bifurcation a stalactite six inches long reached the floor and formed a vertical bar, as if to forbid another ingress. When this had been explored as far as we could crawl, the larger branch (Fig. 83, D, and Fig. 91) engaged our attention, and we soon discovered a third layer of bones of the same character as the others, and in the same position, excepting that in some places it was in immediate contact with the roof. In width it was six, in length fourteen, and in square area eighty-four feet. From its further end to the termination of the passage there was not the slightest vestige of bones or teeth, and a stiff grey clay rested on a horizontal layer of sand on the floor. Here the passage suddenly turned upwards until it became so small and barren that it was not worth our while to pursue it farther. It doubtless rises to the surface, like the large fissure opposite the entrance of the cave shown in Fig. 88.[1]

The exploration was resumed the following year by Mr. Ayshford Sanford and myself, and yielded vast

[1] An incident connected with our work illustrates remarkably the attachment which a dog will suddenly show towards a stranger. In our lodging at Wells there was a beautiful Scotch deerhound, named "Luna," whose master was away at the time. Luna persisted in being with us day and night. In the morning she walked with us to the cave, and lay watching at the entrance till we came out, for she was afraid to venture into the darkness. In the evening she returned home with us. She continued to do this the whole time of that year's excavations. It was only natural to suppose that when we left she would, like other dogs, pick up new friends. But she did nothing of the kind. When we inquired the next year upon our return, we were told that poor Luna refused food the day we left, and gradually pined away and died.

quantities of fossil remains. We cleared out the space marked 1863 in the plan, and discovered a flint implement at the point marked *d*, in Fig 83. My friend the late Mr. Wickham Flower has also worked the cave, more particularly at the right-hand side of the entrance chamber.

The ashes and implements were found in positions, near the mouth of the cave, where man himself may have placed them (see Figs. 83, 88), with the exception of the flint implement at *d*, and an ash of bone imbedded in the earthy matrix between the canine tooth and a coprolite of the hyæna, and cemented to a fragment of dolomitic conglomerate. This was found far in the cave, either at the entrance of the passage B, or in the middle of the passage D. The latter passage yielded the only rolled flint without traces of man's handiwork. The materials out of which the implements were made were used pretty equally. All those, like Fig. 84, were of flint; all those chipped into a rounded form and flat-oval in section of chert from the Upper Greensand; while the flakes consisted of both used indifferently. Besides these three typical forms, which were most abundant, is a fourth, in form roughly pyramidal, with a smooth and flat base, and a cutting edge all round. Of these we found but two examples, both consisting of chert. In form they are exactly similar to several hundreds found in a British village at Stanlake, in Berkshire, and to those I discovered in a cemetery of the same age at Yarnton, near Oxford. They strongly resemble a cast I have of one found by M. Lartet in the cave of Aurignac. Were it not for this similarity, I should look upon them as cores from which flakes had been struck. The rest

are mere splinters, irregular in form, and probably made in the manufacture of the various flint and chert implements. All the flint implements have been altered in colour and structure, either by heat or, as is more probable, by some chemical action. Without exception, the old surfaces present a waxy lustre (by the absence of which forgeries are easily detected), the colour is of a uniform milk-white, and the ordinary conchoidal fracture is replaced by that of porcelain. Some are not harder than chalk. I have met with weathered and calcined flints in Sussex in which similar changes are observable, and in which the difference in the results of chemical action and heat can hardly be detected. The chert implements, on the other hand, show no traces of any such changes, but are similar in colour and structure to the rocks from which they came—the Upper Greensand of the Blackdown Hills.

All the fragments of calcined bone, with the exception of one already mentioned, were found near the entrance (see Fig. 83, *b*), and in a place more suitable for a fire than any other in the cave. I can identify none of them as human. The coarse texture, the structure, and the thickness of one indicate a fragment of a long bone of the rhinoceros.[1] All resemble many splinters strewn about in other parts of the cave, which are not calcined, but were evidently introduced by the hyænas. The calcination may therefore be due to the accident of their lying upon the surface at the time the fire was kindled.

The remains obtained in 1862-3 from three to four thousand in number, afford a vivid picture of the animal life of the time in Somerset. They belong to the fol-

[1] Possibly it may have belonged to *Elephas*, but its more compact texture seems to me to indicate rhinoceros.

lowing animals, the numbers representing the jaws and teeth only, and the implements:—

Man	35	Woolly Rhinoceros	233
Cave-Hyæna	467	*Rhinoceros hemitœchus*	2
Cave-Lion	15	Horse	401
Cave-Bear	27	The Great Urus	16
Grizzly Bear	11	Bison	30
Brown Bear	11	The Irish Elk	35
Wolf	7	Reindeer	30
Fox	8	Red Deer	2
Mammoth	30	Lemming	1

The remains of these animals were so intermingled that they must have been living together at the same time. They lie large with small, the more with the less dense, and are not in the least degree sorted by water. There is no evidence of the hyæna succeeding to the cave-bear, or the reindeer to the urus, or that the bears came here to die, as in some of the German caves, or that the herbivores fell, or were swept into open fissures, and left their remains, as in the caves of Hutton and Plymouth. On the contrary, the numerous jaws and teeth of hyæna, and the marks of those teeth upon nearly every one of the specimens, show that they alone introduced the remains that were found in such abundance. And they preyed not merely upon horses, uri, and other herbivores, but upon one another (Figs. 92, 33), and they even overcame the cave-bear and lion in their full prime. Some of the bones of the larger animals, and in particular a leg-bone of a gigantic urus, have been broken short across and not bitten through—a circumstance which points towards one of the causes of the vast accumulation of bones in so small a cave. It is well known that wolves and hyænas

at the present day are in the habit of hunting in packs, and of forcing their prey over precipices. The Wookey ravine is admirably situated for this mode of hunting, and would not fail to destroy any animal forced into it from the hill-side. It is therefore very probable that the hyænas sometimes caught their prey in this manner. They would not have dared to attack the bears and lions unless these had been disabled.

But if all the remains of the animals were introduced by the hyænas, they certainly in some cases do not occupy the exact position in which they were left by those animals. One of the bone layers (Fig. 91)

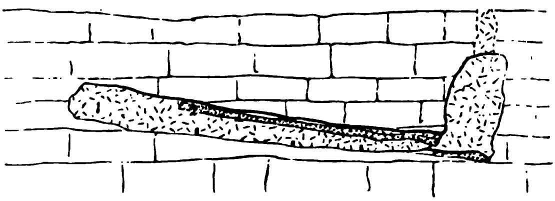


FIG. 91.—Longitudinal Section through D of Fig. 83. Dotted area = bone-bed.

for instance, actually touched the roof. This, indeed, has been used as an argument in favour of their having been introduced by water, from some unknown repository. But if this hypothesis be admitted, we are landed in the following dilemma: either the introducing current of water must have passed down the vertical passages, or upwards through the horizontal mouth of the cave. In the former case the three bone layers would not have been found in the narrow passages, but would have been swept out into the wide chamber, where the force of the hypothetical current must have abated. In the latter case the great bulk of the remains would have

been found in the chamber, and not in the smaller passages. Moreover, the absence of marks of transport by water, and especially of that sorting action which water as a conveying agent always manifests, renders the view of their being so introduced untenable. On the other hand, the horizontality of the layers of bone, and the presence of sand and of red earth, imply that water was an agent in re-arranging the bones and in introducing some of the contents of the cave. The only solution of the difficulty that I can hazard is the occurrence of floods from time to time, during the occupation of the hyænas, similar to those which now take place in the caverns of the neighbourhood. A few years ago, the outlet of the Axe in the great cave was partially blocked up, and the water rose to a height of upwards of sixteen feet, leaving a horizontal deposit of red earth of the same nature as that in the hyæna-den. Now if we suppose that similar floods were caused by an obstruction in the ravine below the hyæna-den, it may have been flooded, just as the upper galleries of the great cave, and the water laden with sediment might have elevated the layers of matted bone, and some of the scattered remains on the surface, while the current was insufficient to disturb the stones, or to affect to any extent the deposits of former floods. The buoyancy of the organic remains is not required to be greater, on this hypothesis, than in that of their having been introduced by a current through the vertical passages. Some of the wet bones taken straight from the cave were sufficiently light to be carried down by the current of the Axe.

All these facts taken together enable us to form a clear idea of the condition of things at the time the hyæna-den was inhabited. The hyænas were the normal occu-

pants of the cave, and thither they brought their prey. We can realize those animals pursuing elephants and rhinoceroses along the slopes of the Mendip, till they scared them into the precipitous ravine, or watching until the strength of a disabled bear or lion ebbed away sufficiently to allow of its being overcome by their cowardly strength. Man appeared from time to time on the scene, a miserable savage armed with bow and spear, unacquainted with metals, but defended from the cold by coats of skin.[1] Sometimes he took possession of the den and

FIG. 92.—Gnawed jaw of Hyæna, from Hyæna-den at Wookey (½).
Dotted outline = portion eaten.

drove out the hyænas; for it is impossible for both to have lived in the same cave at the same time. He kindled his fires at the entrance, to cook his food, and to keep away the wild animals; then he went away, and the hyænas came to their old abode. While all this was taking place there were floods from time to time until eventually the cave was completely blocked up with their deposits.

[1] Bone needles were found in Kent's Hole and in many foreign caves of this age.

The winter cold at the time must have been very severe to admit of the presence of the reindeer and lemming.

The district of the Mendip Hills at a higher level than now.

When we reflect on the vast quantities of the remains of the animals buried in the caves of so limited an area as the Mendip Hills, it is evident that there must have been abundance of food to have enabled them to live in the district. The great marsh now extending from Wells to the sea, and cutting off the Mendips from the fertile region to the south, was probably a rich valley at a higher level than at present, joining the westward plains now submerged under the Bristol Channel. An elevation of from 100 to 300 feet would produce the physical conditions necessary for the sustenance of the herbivora found in the caves both in South Wales and Somersetshire.

The characters of a Hyæna-den.

The remains of the animals which have been eaten by the cave-hyæna, may be recognized by the following characters. All are more or less scored by teeth, and the only perfect bones are those which are solid, or of very dense texture. The skulls are represented merely by the harder portions. That of the woolly rhinoceros, for example, by the hard pedestal which supports the anterior horn (see Fig. 30). Several of these pedestals occurred in the Wookey hyæna-den. The lower jaws also have lost their angle and coronoid process, and are gnawed to the pattern of the shaded portion of Fig. 92, the less succulent part bearing the teeth being rejected.

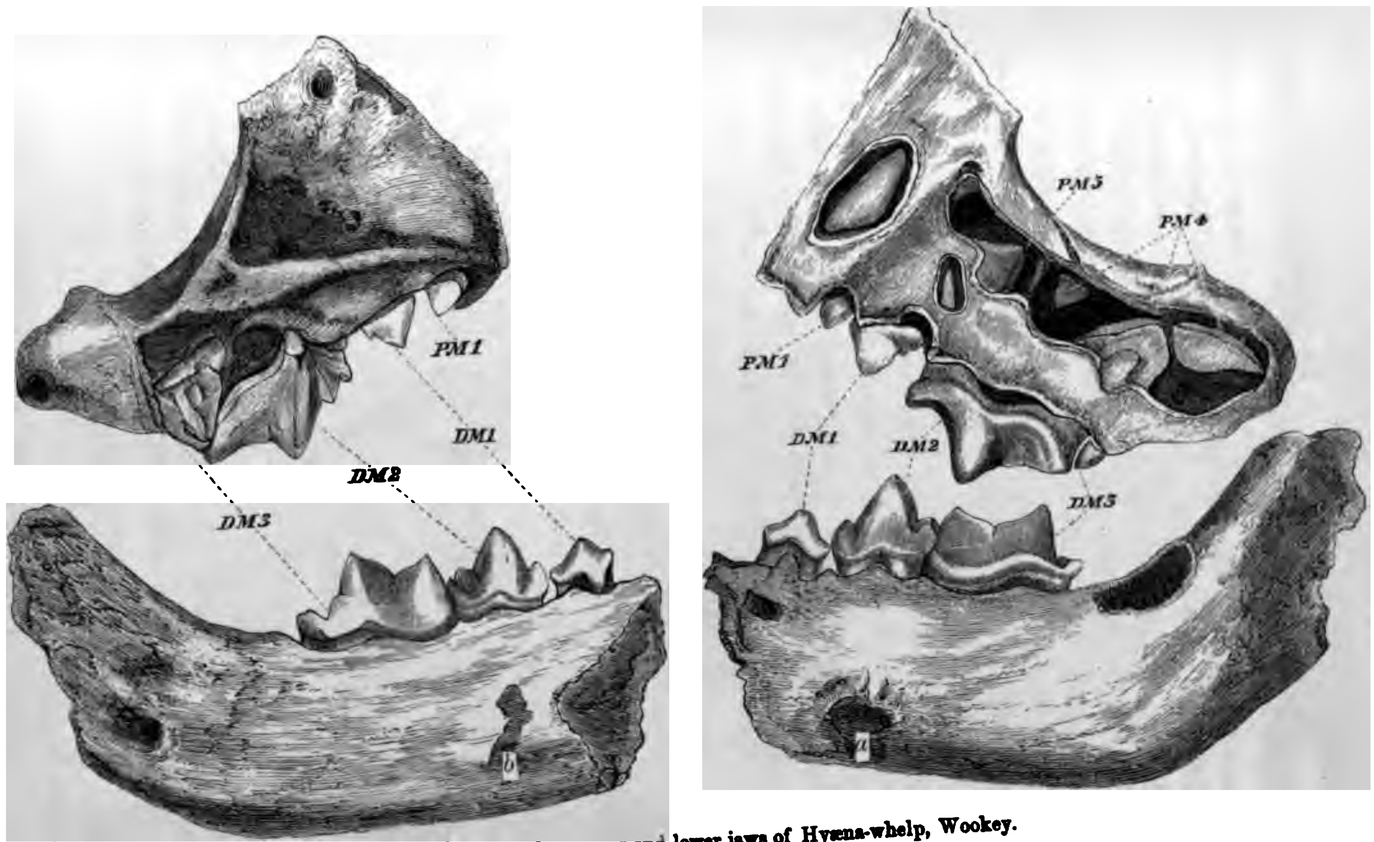


FIG. 93.—A and B, upper and lower jaws of Hyæna-whelp, Wookey.

This holds good of the jaws of all the animals so persistently, that out of more than two hundred from Wookey there was only one exception. The jaw of the glutton (Fig. 82), from Plas Heaton, is also gnawed to the same shape, and one of those of the cave-bear from the cavern of Lherm, considered by M. Garrigou to have been fashioned by the hand of man into an implement, seems to me, after a careful comparison in company with Dr. Falconer, referable solely to the gnawing of the hyæna. In Fig. 92, the lower jaw of an adult hyæna is represented, and in Fig. 93 (1) the upper and lower jaws of a hyæna-whelp. In the latter the teeth marks *a* and *b* are remarkably distinct.[1]

FIG. 94.—Left Thigh-bone of Woolly Rhinoceros gnawed by Hyænas; Shaded parts left. (Wookey Hole.)

The marrow-containing bones are also universally splintered away, until either the articular ends alone are left, as in Fig. 80, or in some cases, as in that of the femur of woolly rhinoceros (Fig. 94), the dense central portion bearing the third trochanter is preserved. This fragment is ex-

[1] These woodblocks were used in my essay on Hyænas in the "Natural History Review," and have been lent by the kindness of Messrs. Williams and Norgate.

tremely abundant in nearly all the hyæna-caves in this country. From the invariable habit of the hyæna leaving the bones of its prey in fragments of this kind, their dens are characterized by the absence of perfect long-bones and skulls, and consequently, when these occur in a cave it is certain proof that it was not occupied by these animals. In a great many caves, however, the gnawed fragments are associated with the perfect bones, as, for example, at Banwell, a circumstance that may be accounted for by the untouched carcases and the gnawed fragments being swept in from the surface by a stream falling into a swallow-hole. In all hyæna-dens also are large quantities of *album græcum*, as well as fragments of bone more or less polished by the friction of the hyæna's feet.

The Caves of Devonshire.

The ossiferous caves on the south coast of Devonshire, explored during the last fifty years, are by far the most important in this country, since they were the first which were scientifically examined, and the first which established the co-existence of man with the extinct mammalia.

We owe the full details of their history to the labours of the distinguished cave-hunter Mr. Pengelly, F.R.S.,[1] whose writings are freely used in the following account.

The Oreston Caves.

The first intimation of the presence of fossil bones in the district was furnished by Mr. Whidbey, the engineer

[1] Pengelly, "Literature of the Oreston Caverns," Trans. Dev. Ass. 1872. Buckland, *op. cit.*

in charge of the construction of the Plymouth breakwater, who discovered numerous bones and teeth, imbedded in clayey loam, in some cavernous fissures at Oreston, which were brought before the Royal Society by Sir Everard Home in 1817. Thus Dr. Buckland's researches in Kirkdale were anticipated by four years. From time to time, since that date, several other fissures and caves close by have furnished remains of rhinoceros, mammoth, hyæna, lion, and other animals. Among the bones and teeth originally sent up by Mr. Whidbey are several which were identified by Prof. Busk,[1] as belonging to the *Rhinoceros megarhinus*, a species that is vastly abundant in the pleiocene strata of northern Italy and is also represented in the early pleistocene forest-bed of Norfolk and Suffolk, and in the lower brickearths of the valley of the Thames at Grays and Crayford. This is the only case on record of the discovery of the animal in a cavern deposit.

The cavernous fissures in the neighbourhood of Yealmpton,[2] about seven miles east-south-east from Plymouth, explored by Mr. Bellamy and Colonel Mudge, R.A., F.R.S. in 1835–6, contained the remains of the hyæna and rhinoceros, and the other animals more usually associated with them. They were probably filled, as in the case of Oreston, mainly by the streams which introduced the pebbles. They may, however, from time to time have been inhabited by the hyænas, although the presence of three skulls of that animal forbids the supposition that they dragged in all the fossil bones.

[1] "Quart. Geol. Journ." xxvi. 457, *et seq.*

[2] "The Literature of the Caverns near Yealmpton, South Devon," by W. Pengelly, F.R.S., F.S.A. Trans. Devon Ass., 1870.

The Caves at Brixham.

The series of fissures accidentally discovered in 1858, in quarrying the rock which overlooks the little fishing town of Brixham, known as the Windmill cave, was selected by the late Dr. Falconer,[1] as a spot in which thorough investigation would be likely to decide the then doubtful question of the co-existence of man with the extinct mammalia. Kent's Hole had been disturbed by repeated diggings, and the results might be viewed with suspicion. He, therefore, urged the importance of a systematic examination of this virgin cave with such effect, that it was undertaken by the Royal and Geological Societies, and a committee was appointed, comprising, amongst others, Dr. Falconer, Prof. Ramsay, Mr. Prestwich, Sir Charles Lyell, Prof. Owen, Mr. Godwin-Austen, and Mr. Pengelly. To the superintendence of the last is mainly due the minute care with which the exploration was conducted. The remains have been identified by Dr. Falconer and Prof. Busk. The work was commenced in July 1858, and completed in the summer of 1859.[2]

The cave consists of three principal galleries, with diverging passages, running in the direction of the joints from north to south, and from east to west, communicating with the surface at four points. The following is the general section (Fig. 95) of the deposits in descending order.

[1] Falconer, "Palæont. Mem." ii. 486, 591.

[2] Proceed. Royal Soc. xx. p. 514. "Report on the Exploration of Brixham Cave," by W. Pengelly, F.R.S., G. Bush, F.R.S., John Evans, F.R.S., and Joseph Prestwich, F.R.S. This report was delayed by the death of Dr. Falconer.

(A.) On the floor was a layer of stalagmite, varying from a few inches to upwards of a foot in thickness, and containing only twenty-five bones, among which were the humerus of a bear, and the antler of a reindeer.

(B.) Reddish cave-earth with fragments and blocks of limestone, and of stalagmite, generally averaging from two to four feet. In it 1,102 bones were discovered irregularly scattered through its mass, and belonging to mammoth, woolly rhinoceros, lion, cave, grizzly, and brown bears, reindeer, and others. They varied in state of preservation, and some were scored and marked by teeth. Associated with these, thirty-six rude flint implements were met with, of indisputable human workmanship, and of the same general order as those figured by the Rev. J. MacEnery from Kent's Hole. Among them was one lanceolate implement with rounded point and unworked butt end, considered by Mr. John Evans, F.R.S., of the type of those usually found in the valley gravels.[1] There was, therefore, the most conclusive evidence that man inhabited the neigh-

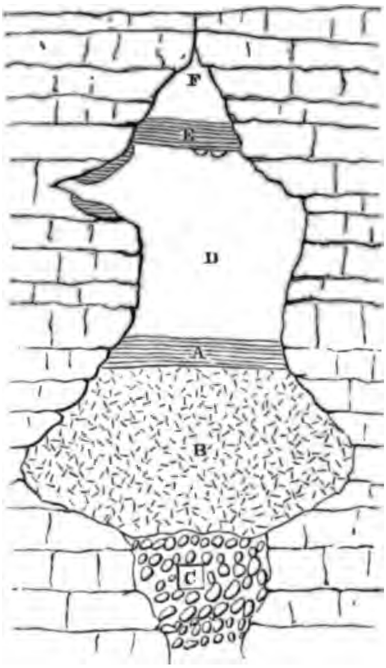


FIG. 95.—Diagram of Deposits in Brixham Cave. (Pengelly.)

[1] "Ancient Stone Implements," p. 46-8.

bourhood, either before or during the time of the accumulation of B, and before those physical changes took place by which the red silt ceased to be deposited, or the stalagmite above began to be formed.

(C.) At the bottom of the cave-earth was a deposit of gravel, principally of rounded pebbles and devoid of fossils.

The early history of the cave, as shown by these deposits, is given by Mr. Prestwich, in the report presented to the Royal Society, as follows :—

"Looking at all the phenomena of Brixham cave, the conclusion your reporter has arrived at is, that the formation of the cave commenced and was carried on simultaneously with the excavation of the valley; that the small streams flowing down the upper tributary branches of the valley entered the western openings of the cave and, traversing the fissures in the limestone, escaped by lower openings in the chief valley, just as the Grotto d'Arcy was formed by an overflow from the cave taking a short cut through the limestone hills, round which the river winds. These tributary streams brought in the shingle bed (Fig. 95, c), which fills the bottom of the fissure. It was only during occasional droughts, when the streams were dry, that the cave seems to have been frequented by animals, their remains being very scarce in that bed, while indications of man are comparatively numerous. As the excavation of the valley proceeded, the level of the stream was lowered and became more restricted to the valley-channel. The cave consequently became drier, and was more resorted to by predatory animals, who carried in their prey to devour, and was less frequented by man. At the same time with the periodical floods, which there is every reason to believe,

from other investigations, were so great during the quaternary period, the cave would long continue to be subject to inundations, the muddy waters of which deposited the silt forming the cave-earth, burying progressively the bones left from season to season by succeeding generations of beasts of prey. By the repetition at distant intervals of these inundations, and by the accumulation during the intervening periods of fresh crops of bones, the bone-bearing cave-earth, B, was gradually formed. During this time the occasional visits of man are indicated by the rare occurrence of a flint implement, lost, probably, as he groped his way through the dark passages of the cave. As the valley became deeper, and as with the change of climate at the close of the (pleistocene) quaternary period the floods became less, so did the cave become drier and more resorted to by animals. At last it seems to have become a place for permanent resort for bears; their remains in all stages of growth, including even sucking cubs, were met with in the upper part of the cave-earth, in greater numbers than were the bones of any other animals. These animals resorted especially to the darker and more secluded flint-knife gallery, where 221 out of 366 of their determinable bones were found, whereas only twenty-six were met with in the reindeer gallery.

"Finally, as the cave became out of the reach of the flood waters, the drippings from the roof, which up to this period had, with the single exception before mentioned, been lost in the accumulating cave-earth, or deposited in thin calcareous incrustations on the exposed bones, now commenced that deposit of stalagmite which sealed up and preserved undisturbed the shingle and cave-earth deposited under former and different condi-

tions. The cave, however, still continued to be the occasional resort of beasts of prey ; for sparse remains of the reindeer, together with those of the bear and rhinoceros, were found in the stalagmite floor. After a time the falling in of the roof at places (and any earthquake movement may have detached blocks from it), and the external surface weathering, stopped up some parts of the cave, and closed its entrances with an accumulation of débris. From that time it ceased to be accessible, except to the smaller rodents and burrowing animals, and so remained unused and untrodden until its recent discovery and exploration."[1]

Mr. Pengelly points out[2] an episode in the history of the cave, between the formation and the filling up with its present contents, which is of considerable importance, viewed in relation to the deposits in Kent's Hole. Over the empty space in D, of Fig. 95, is an ancient stalagmite floor, E, constituting the present ceiling, and shutting off D from the true roof above, E. At the time this was formed, the cave must have been filled up to that level with débris, fragments of which are set in the inferior portion of the calcareous sheet. Subsequently, and before the present contents, A and B, were introduced, the whole of this material has been swept away, probably by an unusual flood similar to that alluded to in the second chapter in the Clapham cave. The pieces of stalagmite in the cave-earth are, probably, some of the relics of the older floor. This filling up, re-excavating, and re-filling with its present contents, are phenomena which considerably complicate the pro-

[1] "Proceed. Royal Soc." 1872, vol. xxii. p. 523-4.

[2] "Trans. Devon Ass." On the Introduction of Cavern Accumulations.

blems offered not merely by Brixham cave, but also by those of Kent's Hole.

Two other caverns in the neighbourhood of Brixham, the "Ash Hole" and "Bench," have also yielded the remains of the reindeer, hyæna, and several other pleistocene species, and are fully described by Mr. Pengelly, in his essays contributed to the Devonshire Association.[1]

Kent's Hole.

The celebrated cave of Kent's Hole,[2] known from time immemorial, was first found to contain fossil bones by Mr. Northmore, and Sir W. C. Trevelyan in 1824, and was subsequently explored by the Rev. J. MacEnery in the five following years, during which he met with flint implements in association with the extinct animals in the undisturbed strata, and obtained the teeth of the sabre-toothed feline, named by Prof. Owen *Machairodus latidens*, which has never before or since been discovered in any other cavern in Britain. His manuscripts unfortunately were not used until they passed into the hands of Mr. Vivian, of Torquay, who published an abstract in 1859. Subsequently they were published in full by Mr. Pengelly, in 1869. The discovery of the flint implements, verified by Mr. Godwin Austen in 1840, and six years later also by a committee of the Torquay Natural History Society, was received with incredulity by the scientific world, until the result of the

[1] "Trans. Devon Ass." 1870.

[2] Pengelly, "Literature of Kent's Hole:" Trans. Ass. Devon. 1868 9-70. Godwin Austen, "Proceed. Geol. Soc." iii. 286-7. "Trans. Geol. Soc." vi. p. 433, *et seq.* Vivian, "Brit. Ass. Rep." 1847, p. 73.

exploration of the Brixham cave had placed the fact of the co-existence of man with the extinct mammalia beyond all doubt. In 1864 a committee[1] was appointed by the British Association for the carrying on the investigation, which from that time to the present has been conducted under the careful supervision of Mr. Pengelly.

The cave consists of two parallel series of chambers and galleries, an eastern and a western, which penetrate the low cliff of Devonian limestone in the direction of the joints, with a northern and southern entrance, very nearly at the same level, "about fifty feet apart, from 180 to 190 feet above the level of mean tide, and about seventy feet above the bottom of the valley immediately adjacent." The largest chamber of the eastern series is sixty-two feet from east to west, and fifty-three from north to south. The extent of the cave has not yet been ascertained.

The contents, examined with the minutest care (on Mr. Pengelly's method, see Appendix I.), were found to be arranged in the following order.

(A.) The surface was composed of dark earth varying in thickness from a few inches to a foot, on which rested large blocks of limestone, fallen from the roof. It contained mediæval remains, Roman pottery, and combs fashioned out of bone, similar to those discovered in the Victoria and Dowkerbottom caves in Yorkshire, which prove that the cave was frequented during the historic period. A barbed iron spear-head, a bronze spear-head, other bronze articles, and polished stone celts, establish

[1] The committee consisted of Sir C. Lyell, Prof. Phillips, Sir John Lubbock, Mr. John Evans, Mr. Edward Vivian, Mr. William Pengelly, to which subsequently Mr. George Busk, Mr. Boyd Dawkins, and Mr. Ayshford Sanford were added.

the fact that it was also used during the iron, bronze, and neolithic ages. This stratum contained the broken bones of the short-horn (*Bos longifrons*), goat, and horse, large quantities of charcoal, and was to a great extent a refuse-heap like that in the Victoria cave.

(B.) Below this was a stalagmite floor, varying in thickness from one to three feet, covering

Fig. 96. — Lanceolate Implement from Kent's Hole (½). (Evans.)[1]

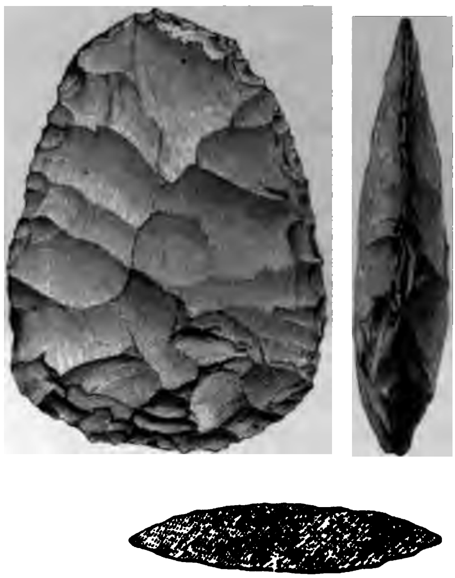


Fig. 97.—Oval Implement from Kent's Hole (½) (Evans.)

(C.) The red earth, with stones, bones of the extinct animals, and flint implements, associated together in the greatest confusion, as well as large lumps of stalagmite and of breccia, which had been torn out of a pre-existent floor. In the "vestibule," near one of the entrances, a black layer beneath the stalagmite, com-

[1] For Figs. 96 to 100 I am indebted to the kindness of Mr. Evans.

posed, to a great extent, of charcoal, indicated the position of the fire-places, and contained a vast number of rude unpolished palæolithic implements. There were also local stalagmitic bands. The flint implements were met with at various depths, and consist of three distinct types: the lanceolate, Fig. 96, the oval, with edge carefully chipped for cutting, Fig. 97, and the flake (see

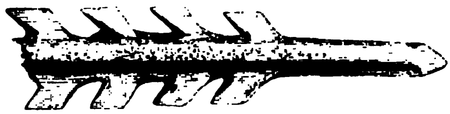


FIG 98.—Harpoon from Kent's Hole (½). (Evans.)

Fig. 106). Besides these a few implements have been discovered of the same shape as those found in the gravel beds; in outline and section roughly triangular, and tapering to a point from a blunt base, which was probably intended to be held in the hand.[1] Several articles of bone and antler were also met with, comprising an awl, or piercer, a needle with the eye large enough to

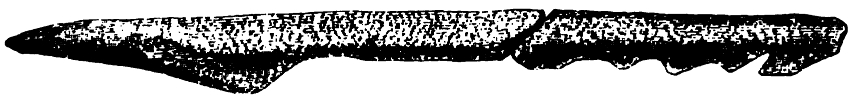


FIG. 99.—Harpoon-head from Kent's Hole (½). (Evans.)

admit small packthread, and three harpoon-heads, one of which is barbed on both sides (Fig. 98), the others being merely barbed on one side (Fig. 99). A rounded pebble of coarse red sandstone, battered into a cheese-like form, by being used as a hammer (Fig. 100), was also found. All these articles bring the palæolithic inhabitants of Kent's Hole into relation with those of the caves and

[1] See Evans' "Ancient Stone Implements," Fig. 388. It is unnecessary to describe the implements.

rock-shelters of the south of France, to be described in the next chapter.

(D.) The cave-earth rested on a compact, dark red breccia composed of angular fragments of limestone and pebbles of sandstone embedded in a sandy calcareous paste, identical in constitution with the fragments of the older breccia discovered in the cave-earth. It has furnished bones of bears, and four flint implements. The cave-earth, C, and the breccia, E, seem to stand to one another in an inverse ratio as regards thickness: where the former was thin, the latter was sometimes as much as twelve feet thick. From this relation, as well as from

FIG. 100.—Hammer-stone (½). (Evans.)

the imbedded fragments of the latter, it may be concluded that the former is the more modern, and that in the interval between their accumulation the latter had been, to a considerable extent, broken up.

There is very good reason for the belief, that before any of the present cave-earth was introduced, Kent's Hole had been filled nearly to the roof by an older cave accumulation, now represented by the undisturbed breccia and the included fragments. In a portion of the cave termed the "gallery," there is a sheet of stalagmite, extending overhead from wall to wall, and constituting a ceiling that reaches from wall to wall,

without further support than that offered by its own cohesion. Above it, in the limestone rock, there is a considerable alcove. This branch of the cavern, therefore, is divided into three stories or flats, that below the floor occupied with cave-earth, that between the floor and the ceiling entirely unoccupied, and that above the ceiling also without a deposit of any kind. For such a sheet of stalagmite to have been formed it is absolutely necessary for the cave to have been filled up to its level with materials of some kind, just as it is necessary for the formation of a film of ice that it should be crystallized from the surface of water. We may, therefore, infer that Kent's Hole, like Brixham, was originally filled up to the level of the ceiling (see Fig. 95, E), then that the contents were swept out, with the exception of the breccia, and lastly, that the present cave-earth was introduced. The occurrence of the remains of bear, and of flint implements, in this breccia also proves that man and bears were living in the district, while it was being accumulated, probably by the action of the floods to which, from time to time, the cave was subjected. All the flint implements in the breccia are of the ruder and larger form which is presented by those from the pleistocene deposits of the Somme, Seine, and the rivers of the south and east of England.

While engaged in the identification of the mammals in 1869, with Mr. W. A. Sanford, I detected splinters of bears' canines, from the cave-earth, remarkable for their density, crystalline structure, and semi-conchoidal fracture, which were in the same mineral state as those from the older breccia. One of these had been fashioned into a flake after its mineralization, and presented an edge chipped by use. The tooth from which

it was struck was, probably, imbedded and mineralized in the older breccia, then washed out of it, and afterwards chosen for the manufacture of an implement. It was already fossil and altered in structure in the palæolithic age.

The probable Age of the Machairodus of Kent's Hole.

The most remarkable animal discovered in the cave, by the Rev. J. MacEnery, is the *Machairodus latidens*,[1] or large lion-like animal, armed with double-edged canines, in shape like the blade of a sabre, and with two serrated edges. Five canines and two incisors were dug out of the cave-earth, c, in the Wolf's Passage, along with vast quantities of bones and teeth of the mammoth, rhinoceros, Irish elk, horse, and hyæna. One of the canines is represented in Figs. 101, 102, which are taken from one of the original plates drawn for Dr. Buckland, and now in the Museum of the Torquay Natural History Society. The two incisors, Figs. 103, 104, 105, are also characterised by their serrated edges. A third was discovered by the exploration committee in the same spot, in 1872, scarcely to be distinguished from that in Figs. 103, 104, which finally dispelled the scepticism of some eminent naturalists as to whether any of these teeth had been obtained in the cave by the Rev. J. Mac Enery.

The *Machairodus latidens* has been found in pleistocene strata in two localities in France: in a deposit of diluvium, near Puy, by M. Aymard, and in the cavern of Baume in the Jura, considered by M. Lartet to be of

[1] For an account of Machairodus, see "Brit. Pleistocene Mammalia," Palæont. Soc., *Felidæ*, cxxii. p. 184.

preglacial age.[1] In the latter it was associated with the horse, ox, wild-boar, elephant, a non-tichorine species of rhinoceros, the cave-bear, and the spotted hyæna. In the autumn of 1873, I met with proof that the animal also lived in France in the pleiocene period. M. Lortet, the Director of the Museum of Natural History, at

101 102

FIGS. 101, 102.—Upper Canine of Machairodus, Kent's Hole (1/1). (MacEnery.)

Lyons, called my attention to a canine, in the Palais des Beaux Arts, which coincides exactly in all its dimensions with one of those from Kent's Hole. It was found at Chagny (Saône et Loire) near Dijon, along with *Masto-*

[1] Gervais, "Zool. et Paléont. Françaises," 1859, p. 251. "Animaux Vertébrés, Vivants et Fossiles," 1867-9, p. 78, pl. xviii. Lartet, Prehistoric Congress, Paris Volume, 1868, p. 269.

[illegible]

[illegible] species of [illegible] Europe and North America, as well as in the [illegible] of Europe.

[illegible] Figs. 103, 104, 105, [illegible] we have unmistakable traces [illegible] the spotted [illegible] marks in [illegible]. It seems, therefore, [illegible] inhabited Devonshire during [illegible] period, before the arctic [illegible] possession of the valley of the English Channel, and of the low grounds which now lie within the 100-fathom line off the Atlantic shore of Western France. There must necessarily have been a swinging to and fro of animal life over the great, fertile, low-lying region, which is now submerged (see Map, Fig. 126); and before the temperature of France had been sufficiently lowered to exterminate or drive out the southern forms, it is most natural to suppose that in warm seasons some of the southern mammalia would find their way northwards, and espe-

cially a formidable carnivore such as the machairodus. The extreme rarity of its remains forbids the hypothesis that it was a regular inhabitant of Britain during the pleistocene age.

On the other hand, the recent discovery of a second incisor in the uppermost portion of the cave-earth, in July 1872, in the same condition as the remains usually found, and associated with the bones and teeth of hyæna, horse, and bear, is considered by Sir Charles Lyell and

103 104 105

FIGS. 103, 104, 105.—Incisors of Machairodus, Kent's Hole (1/1). (MacEnery.)[1]

Mr. Pengelly proof of the animal having lived during the deposition of the later cave-earth, or in the later stage of the pleistocene. The condition of a bone, however, is a very fallacious guide to its antiquity, and although the fragments of the older contents of the cave are in a different mineral state, it is improbable that the ossiferous contents of so large a cave should have been mineralized exactly in the same way. Nor is an appeal to its perfect

[1] These figures have been kindly lent by the Palæontographical Society.

state conclusive, since several teeth of bear, which I have examined from the breccia, are equally perfect.

The view of the high antiquity of machairodus in Kent's Hole derives support from the discovery of *Rhinoceros megarhinus* at Oreston, a species which is very abundant in the Italian pleiocene strata, and not uncommon in those of France,—a species with its head-quarters in the south, but ranging as far north as Norfolk in the early stage of the pleistocene age, represented by the forest bed of Cromer, and that lived in the valley of the Thames, while the gravel-beds of Crayford and Grays Thurrock were being deposited by the ancient river. The occurrence of either of these animals in a cave is exceptional, and the presence of both in caves on the edge of the great plain extending southwards from the present coastline of Devon, seems to me to imply that both were open during the early stage of the pleistocene, while the pleiocene mammalia were retreating before the southward advance of the mammoth, woolly rhinoceros, spotted hyæna, reindeer, and their congeners, at a time anterior to the lowering of the temperature that culminated in the glacial period. For these reasons it seems to me probable that the machairodus belongs to an early rather than a late stage in the history of Kent's Hole.

There is an important point of resemblance between the mode of the occurrence of the machairodus in Kent's Hole, and of the megarhine rhinoceros at Oreston. The remains of both were met with only *in one spot*, and were not scattered through the chambers and passages. It may have happened that in the physical changes which those caves have undergone, both were preserved in a fissure like that described in the Uphill cave

(p. 294), and that subsequently they dropped down and became imbedded in a newer deposit. In fixing the age of strata in caves it seems to me that the zoological evidence is of far greater weight than that of mere position, which may be the result of accidental circumstances.

The Caves of Ireland.

The caves of Ireland would probably afford as rich a fauna as those of Britain, had they been explored with equal care. In one at Shandon, near Dungarvan, Waterford, remains of the brown bear (*U. arctos*) reindeer, horse, and mammoth were discovered in 1859, by Mr. Brenan.[1] The first of these animals became extinct in Ireland before the historic period, while it survived in Britain at least as late as the Roman occupation.

The cave-bear is also recorded by Dr. Carte,[2] from the same place, but the thigh bone assigned to it seems to me to belong to the brown, or common species. The mammoth, so abundant in Britain, has only been discovered in two other localities in Ireland, at Whitechurch near Dungarvan, and at Magherry near Belturbet.[3]

The range of these animals over Great Britain and Ireland in the pleistocene age enables us to realize the ancient physical geography, which will be treated in the next and following chapters as part of the general question of the physical condition of north-western Europe at that time.

[1] "Journ. Royal Dublin Soc." ii. p. 344.

[2] "Journ. Geol. Soc. Dublin," x. p. 147. "Journ. Royal Dublin Soc." ii. p. 352.

[3] Scott, "Geol. Soc. Dublin," Feb. 10, 1864.

[illegible]

[illegible] already described. [illegible] with which have [illegible] this country. In the cave of [illegible] striped hyæna of [illegible] (*Hyæna striata*) has been found by Marcel de Serres, [illegible] the credit of being the first systematic explorer of caverns in France. In that of Bruniquel the [illegible], now found only in the higher mountains in Europe, the chamois and the *Antelope saiga*, an animal

inhabiting the plains of the region of the Volga and of southern Siberia, have been identified by Prof. Owen; while in the collection obtained by Mr. Moggridge from the caves of Mentone, Prof. Busk has recognized the marmot. With these exceptions there is no distinction between the faunas of the bone-caves of this country and of France.[1]

The Cave of Baume.

The *Machairodus latidens*,[2] or great sabre-toothed feline of Kent's Hole, has been discovered in the cave of Baume in the Jura, according to M. Gervais,[3] along with the horse, ox, wild-boar, elephant, a non-ticho-rhine species of rhinoceros, the spotted hyæna, and the cave-bear, or the same group of animals as that with which it is found in Kent's Hole. The cave is considered by M. Lartet[4] to be of preglacial age.

The Caves of Périgord.

The caves and rock-shelters of Périgord, explored by the late M. Lartet and our countryman, Mr. Christy,[5]

[1] An account of the numerous caves of France will be found in the works of M. de Serres, the "Revue Archéologique," "Les Matériaux pour l'Histoire de l'Homme."

[2] Boyd Dawkins, "Brit. Pleist. Mam. Palæont. Soc." 1872, p. 189.

[3] Gervais, "Animaux Vertébrés," p. 78, pl. xviii.

[4] Lartet, International Congress, Paris Volume, p. 269.

[5] "Cavernes du Périgord," "Revue Archéologique," 8vo. 1864. "Reliquiæ Aquitainicæ," 4to. 1865–74. This magnificent history of the researches, in the prosecution of which Mr. Christy lost his life, was published at his expense under the editorship of Prof. Rupert Jones, F.R.S., to whom I am indebted for the liberty to use the letterpress and engravings quoted in this book.

1863-4, have not only afforded cumulative proof of the co-existence of man with the extinct mammalia, but have given us a clue as to the race to which he belonged. They penetrate the sides of the valleys of the Dordogne and Vezère at various levels, as may be seen in Fig. 71, and are full of the remains left behind by their ancient inhabitants, which give as vivid a picture of the human life of the period, as that revealed of Italian manners in the first century by the buried cities of Herculaneum and Pompeii. The old floors of human occupation consist of broken bones of animals killed in the chase, mingled with rude implements, weapons of bone, and unpolished stone, and charcoal and burnt stones which point out the position of the hearths.

Flakes (Fig. 106) without number, rude stone-cutters, awls, lance-heads, hammers, saws made of flint or of chert, rest pêle-mêle with bone needles, sculptured reindeer antlers, engraved stones, arrow-heads, harpoons, and pointed bones, and with the broken remains of the animals which had been used as food, the reindeer, bison, horse, the ibex, the saiga antelope, and the musk sheep. In some cases the whole is compacted by a calcareous cement into a hard mass, fragments of which are to be seen in the principal museums of Europe. This strange accumulation of débris marks, beyond all doubt, the place where ancient hunters had feasted, and the broken bones and implements are merely the refuse cast aside. The reindeer formed by far the larger portion of the food, and must have lived in enormous herds at that time in the centre of France. The severity of the climate at the time may be inferred by the presence of this animal, as well as by the accumulation of bones on the spots on which man had fixed his habitation. Indeed, had not this been the

case, the decomposition of so much animal matter would have rendered the place uninhabitable even by the lowest savage.

Besides the animals mentioned above, the cave-bear and lion have been met with in one, and the mammoth in five localities, and their remains bear marks of cutting

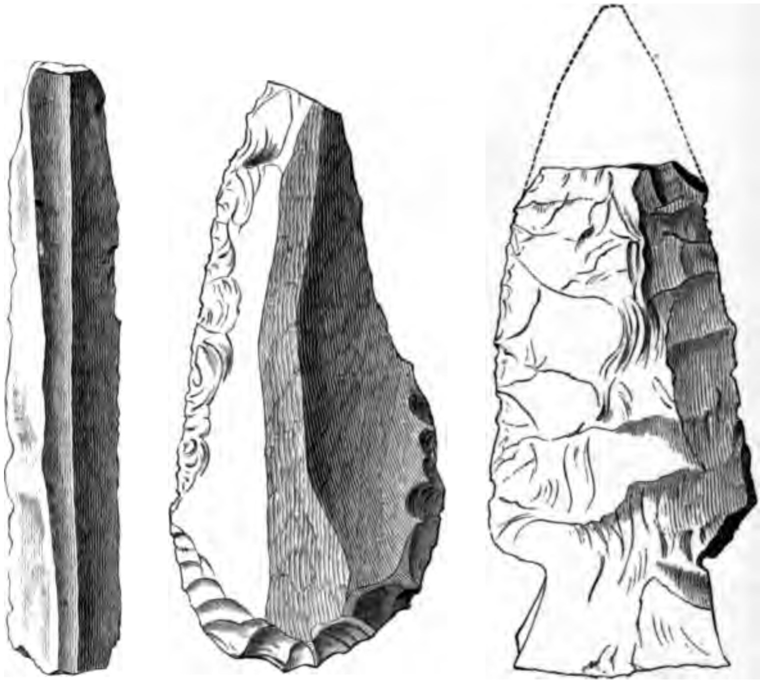


FIG. 106. — Flint-flake, Les Eyzies (1/1). (Lartet and Christy.)

FIG. 107.—Flint Scraper, Les Eyzies (1/1). (Lartet and Christy.)

FIG. 108.—Flint Javelin-head, Laugerie Haute (1/1). (Lartet and Christy.)

or scraping, which show that they fell a prey to hunters. The Irish elk, also, and the hyæna occur respectively in the cave of Laugerie Basse, and of Moustier, but the latter certainly did not gain access to the refuse-heaps, because the vertebræ are intact which it is in the habit of eating.

For the same reason also, M. Lartet infers that the hunters were not aided in the chase by the dog. There is no evidence that they were possessed of any domestic animal. There were no spindle wheels to indicate a knowledge of spinning, nor potsherds to show an acquaintance with the potter's art. In both these respects they resemble the Fuegians, Eskimos, and Australians, and contrast strongly with the neolithic races.

FIG. 109.—Flint Arrow-head, Laugerie Haute (1/1). (Lartet and Christy.)

FIG. 110.—Bone needle, La Madelaine (1/1). (Lartet and Christy.)

The broken bones show that the reindeer furnished the more usual food, and next to that the horse, and then the bison. And from the absence of the vertebræ and pelvic bones of the two latter animals, M. Lartet concludes that they were cut up where they were killed, and the meat stripped from the backbone and the pelvis. Their food was probably cooked by boiling, the number of round stones used for heating water and bearing

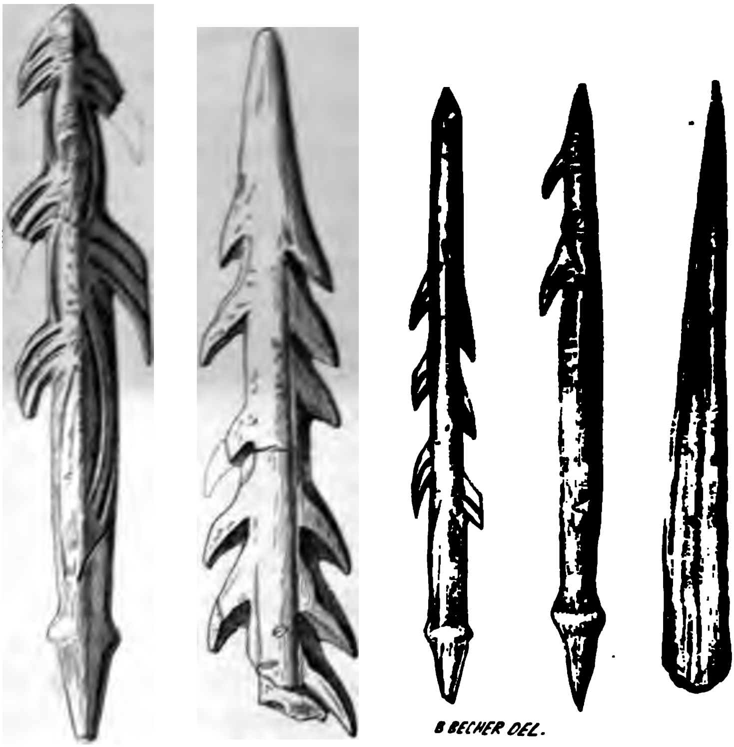
marks of fire, like the "pot boilers" of some of the American Indians, being very considerable.

Among the stone implements flint flakes were incredibly numerous, and the number of chips scattered about as well as the blocks of flint from which they had been struck, proved that they had been made on the spot; most of these flakes were notched by use (Fig. 106). Instruments with the ends carefully rounded off (Fig. 107) were also abundant, and from their analogy with similar instruments used by the Eskimos, there can be but little doubt that they were intended for the preparation of skins (compare Fig. 107 with Fig. 124). The ends of some were chipped to a point for insertion into a handle, while others rounded at both ends were probably used freely in the hand. In the cave of Moustier oval implements were met with, resembling those figured from the caverns of Kent's Hole and Wookey (Figs. 84 and 97). The spear, javelin, and arrow-heads of flint presented two modes of attachment to the shaft, the base of some being squared off with a notch above for the ligature (as in Fig. 108), while in others (Fig. 109) it tapered off into a point intended for insertion. This latter form has been obtained also in Kent's Hole.

The bone needles are carefully smoothed, and were pierced with a neatly-made eye (Fig. 110) by means of pointed flakes which were found along with them, and the use of which M. Lartet demonstrated by experiment. They had been sawn out of the compact metacarpals and tarsals of the reindeer[1] and the horse, and subsequently rounded on fragments of sandstone, the grooves of which fitted them. In this, therefore,

[1] The same bones of the ox and horse are now imported into Britain from South America for the manufacture of buttons.

we have not merely the evidence that the hunters were in the habit of sewing, but also we have vividly brought before us the very method by which their needles were manufactured. They were probably used for sewing skins together, the tendon of a reindeer forming the thread, as among the modern Eskimos.



111 112 113 114 115

FIGS. 111, 112.—Harpoons of Antler, La Madelaine. (Lartet and Christy.)
FIGS. 113, 114.—Arrow-heads, Gorge d'Enfer. (Broca.)
FIG. 115.—Bone Awl, Gorge d'Enfer (½). (Broca.)

The heads of arrows and lances are made principally out of reindeer antler, and are barbed, the barbs generally being grooved, and carved on both sides of the axis

(Figs. 111, 112, 113) ; but in some cases, as in Fig. 114, the barbs are only on one side. Many bones and antlers are variously carved into shapes for which it is impossible to assign a definite use. Fig. 115 is a bone awl.

The most remarkable remains left behind by man in these refuse-heaps are the sculptured reindeer antlers, and the figures engraved on fragments of schist and on ivory. A well-defined outline of an ox stands out boldly from one piece of antler. A second presents us with a most elegant design : a reindeer is kneeling down in an easy attitude with its head thrown up in the air, so that the antlers rest on the shoulders, and the back of the animal forms an even surface for a handle, which

FIG. 116.—Carved Handle of Reindeer Antler ($\frac{3}{4}$). (Lartet and Christy.)

is too small to be grasped in an ordinary European hand (Fig. 116). In a third a man stands close to a horse's head, and hard by is a fish like an eel; and on the other side of the same cylinder are two heads of bison, drawn with sufficient clearness to ensure recognition by anyone who had ever seen that animal (Fig. 117). On a fourth the natural curvature of one of the tines has been taken advantage of by the artist to engrave the head, and the characteristic recurved horns of the ibex ; and on a fifth are figures of horses (Fig. 118), in which the upright disheveled mane and shaggy ungroomed tail are represented with admirable spirit. At first sight it would

appear that the artist had drawn the heads out of all proportion to the bodies. A horse's skeleton, however, from the palæolithic "station" at Solutré, lately set up in the Museum at Lyons, proves that this is not the case, since, as M. Lortet pointed out to me, it is remarkable

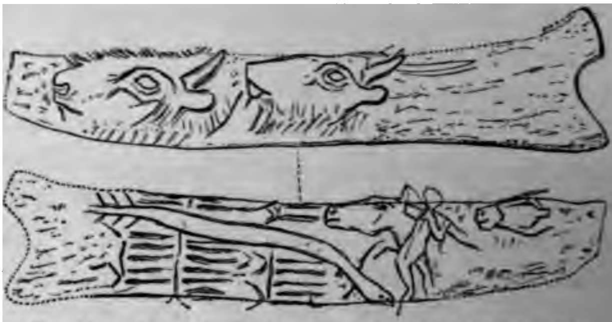


FIG. 117.—Two sides of Reindeer Antler, La Madelaine (½). (Lartet and Christy.)

for its massive head, and small body. In Fig. 119 a group of reindeer are seen, two on their backs, and two in the act of walking. The Irish elk, red-deer, and probably rhinoceros, are also depicted, the figures upon the hard schist being feebly and uncertainly drawn,

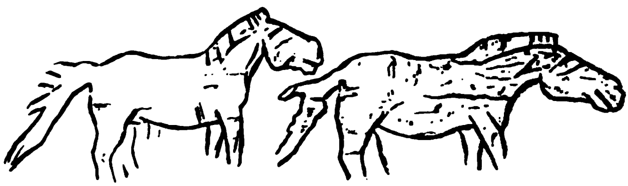


FIG. 118.—Horses engraved on Antler, La Madelaine (½). (Lartet and Christy.

as might be expected from the character of the tools. The most clever sculptor of modern times would, probably, not succeed very much better if his graver was a splinter of flint, and stone and bone were the materials to be engraved. One peculiarity runs through the figures of animals. With but two exceptions none

of the feet are represented, a circumstance which is probably due, as Mr. Franks has suggested to me, to the fact that the hunters merely represented what they saw of the animal, of which the feet would be concealed by the herbage.

The most striking figure that has been discovered is that of the mammoth,[1] Fig. 120, engraved on a fragment of its own tusk, the peculiar spiral curvature of the tusk and the long mane, which are not now to be

FIG. 119.—Group of Reindeer, Dordogne. (Broca.)

found in any living elephant, proving that the original was familiar to the eye of the artist. The discovery of whole carcases of the animal in northern Siberia, preserved from decay in the frozen cliffs and morasses, has made us acquainted with the existence of the long hairy mane. Had not it thus been handed down to our eyes, we should probably have treated this most accurate drawing as a mere artist's freak. Its peculiarities are so faithfully depicted that it is quite impos-

[1] Boyd Dawkins, "Range of the Mammoth," Pop. Sc. Rev. July, 1868.

sible for the animal to be confounded with either of the

FIG. 120.—Mammoth engraved on Ivory, La Madelaine (½). (Lartet and Christy.)

two living species. These drawings probably employed

the idle hours of the hunter, and perpetuate the scenes which he witnessed in the chase. They are full of artistic feeling, and are evidently drawn from life. The mammoth is engraved on its own ivory, the reindeer generally on reindeer antler, and the stag on stag antler.

From all these facts we must picture to our mind, that these ancient dwellers in the caves of Aquitaine lived by hunting and fishing, that they were acquainted with fire, and that they were clad with skins sewn together with sinews or strips of intestines. That they did not possess the dog is shown, not merely by the negative evidence of its not having been discovered, but also by the fact that the bones which it invariably eats, such as the vertebræ, are preserved. They did not possess any domestic animals, and there is no evidence that they were acquainted with the potter's art. M. de Mortillet's view, that the art of making pottery was unknown in the palæolithic age, seems to me to be probably true, the reputed cases of the discovery of potsherds being always connected with suspicious circumstances, which render it probable that they were subsequently introduced.

Besides the remains of the animals in the refuse-heaps were fragmentary portions of human skeletons, which, however, were not scraped or broken so as to imply the practice of cannibalism.

Caves of Belgium.

The researches of Dr. Schmerling[1] into the caves of Belgium, in 1829–30, revealed the fact that the animals

[1] "Recherches sur les oss. foss. découverts dans les Cavernes de Liége." 4to.

so abundant in the caves of Germany, were equally numerous in those in the neighbourhood of Liége, and the flint flakes, and the fragments of human bones, which he found may possibly be of palæolithic age. He also discovered the remains of the porcupine, a species no longer living north of the Alps and Pyrenees. The systematic exploration, however, of the palæolithic caves in that district was not carried out until, in the year 1864, M. Dupont[1] began the investigation of those in the neighbourhood of Dinant-sur-Meuse, on behalf of the Belgian Government. His results, based upon the

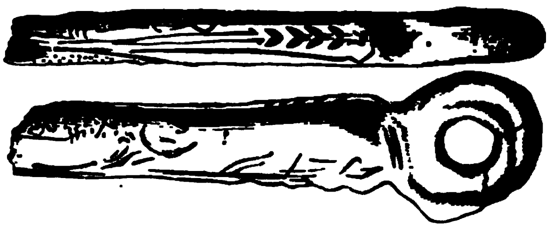


FIG. 121.—Carved Implement of Reindeer Antler, Goyet (½). (Dupont.)

examination of upwards of twenty caves and rock-shelters, are published in a series of papers read before the Royal Academy of Belgium and subsequently in a separate work. Besides the remains of the animals living in Belgium within the historic period, he met with the ibex, chamois, and marmot, which are now to be found only in the mountainous districts of Europe, the tailless hare, lemming, and arctic fox, of the northern regions, the *Antelope saiga*, grizzly bear, lion, hyæna, and others. Most of these species occurred in refuse accumulations, their remains being in the fragmentary condition of those of the French caves. The

[1] Dupont, "L'Homme pendant les Ages de la Pierre dans les Environs de Dinant-sur-Meuse." 2nd edit. p. 187.

associated implements are of the same type as those of Périgord, and some of them are ornamented in the same manner as, for example, that from the cavern of Goyet, Fig. 121, termed a "bâton de commandement," but which, from its analogy with similar articles in the British Museum, is most probably an arrow-straightener. Those of flint are also of the same kind, and in several of the caves there was the same association of fragmentary human remains with the relics of the feasts as in the French refuse-heaps.

Trou de Naulette.

The human remains consisting of a lower jaw, ulna and metatarsal, discovered in the large cavern of Naulette,[1] on the left bank of the Lesse, in association with the broken remains of the rhinoceros, mammoth, reindeer, chamois, and marmot, are undoubtedly of palæolithic age, since they rested in an undisturbed stratum. M. Dupont gives the following section in descending order.

		METRES.
1.	Sandy grey and yellow clay	2·90
2.	Yellow grey clay with stones and bones of ruminants	0·45
3.	Stalagmite.	
4.	Tufa.	
5.	Three bands of clay alternating with stalagmite.	
6.	Sandy clay with human bones at the depth of four metres.	
7.	Stalagmite.	
8.	Cave-earth with bones gnawed by hyænas.	

The human jaw is remarkable for its prognathism, which, according to Dr. Hamy, is greater than that which

[1] Dupont, *op. cit.* "Bull. Acad. Roy. de Belgique," xxii. p. 20. Hamy, "Paléontologie Humaine," p. 231.

has been observed in any living races. The cave had afforded shelter to the hyænas before it had been used by man.

The Caves of Switzerland.

The caves of Switzerland also contain the same class of rude implements and carvings. Prof. Rupert Jones has called my attention to a recent discovery of carved reindeer antlers, and harpoon-heads, similar to those figured from the Dordogne, in a cave in the Canton of Schaaffhausen,[1] along with the bones of hyæna, reindeer, and mammoth. In that of Veyrier,[2] carved implements were found along with the remains of the ox, horse, chamois, and ibex, some of which, shown to me by Dr. Gosse, at the meeting of the French Association for the Advancement of Science, at Lyons in 1873, are of the same form and size as the arrow-straightener from the cave of Goyet (Fig. 121).

We may, therefore, infer that the same palæolithic race of men once ranged over the whole region from the Pyrenees and Switzerland, as far to the north as Belgium. And since Prof. Fraas has obtained similar implements from a refuse-heap at Schussenreid in Würtemberg, they wandered as far to the east as that district, while the discoveries in Kent's Hole and Wookey Hole prove that they extended as far to the west as Somersetshire and Devonshire.

[1] The discovery will shortly be published by Prof. Heine, of Zurich.

[2] "Matériaux pour l'Histoire de l'Homme," May 1869, p. 272.

Cave-dwellers and Palæolithic Men of the River-gravels.

These palæolithic cave-dwellers are considered by Mr. Evans[1] to belong to the same race as those who have left their rude flint implements in the river-gravels in the valleys of the Thames, the Somme, the Seine, and in the eastern counties, as far to the north as Peterborough. We must, however, allow that a marked difference is to be observed between a series of flint implements found in the caves, as compared with a series found in the river-strata, although some forms are common to the two; as for instance some of those found in Brixham and Kent's Hole. This difference can scarcely be explained on the supposition that the small things would be less likely to be preserved in the fluviatile deposits, because it leaves the rarity in the caves of the larger fluviatile forms unaccounted for. It is perhaps safer, in the present state of our knowledge, to consider the two sets to be distinct from each other. The direct superposition in Kent's Hole of the stratum with the ordinary cave-type of implement, over that with the ordinary fluviatile type, may perhaps prove that the latter is the older.

Classification of Palæolithic Caves.

The palæolithic caves are divided by M. Lartet[2] into four groups, according to the species of animals which they contain; into those of the age of the cave-bear, of the age of the mammoth and woolly rhinoceros, of the

[1] "Ancient Stone Implements."
[2] "Ann. des Sc. Nat." 4th sér. t. 15, p. 231.

age of the reindeer, and of the age of bison. Dr. Hamy follows Sir John Lubbock,[1] in considering the age of the cave-bear to be co-extensive with that of the mammoth, and in the classification of caves he adopts a series of transitions. M. Dupont divides the caves of Belgium into those belonging to the age of the mammoth, and to that of the reindeer.

It is easy to refer a given cave to the age of the reindeer or of the mammoth because it contains the remains of those animals, but the division has been rendered worthless for chronological purposes, by the fact that both these animals inhabited the region north of the Alps and Pyrenees at the same time, and are to be found together in nearly every bone-cave explored in that area. The difference between the contents of one palæolithic cave and another, is probably largely due to the fact that man could more easily catch some animals than others, as well as to the preference for one kind of food before another. And the abundance of the reindeer, which is supposed to characterise the reindeer period, may reasonably be accounted for by the fact, that it would be more easily captured by a savage hunter, than the mammoth, woolly rhinoceros, cave-bear, lion, or hyæna. The classification will apply, as I have shown in my essay on the pleistocene mammalia,[2] neither to the caves of this country, of Belgium, nor of France, and my views are shared by M. de Mortillet,[3] after a careful and independent examination of the whole evidence.

The division of the caves also into ages, according to

[1] Hamy, *op. cit.* Lubbock, "Prehistoric Man."

[2] "Quart. Geol. Journ." June 5, 1872.

[3] Prehistoric Congress, Brussels Volume, 1872, p. 432. "Mém. Anthrop. Soc. de Paris," 2nd sér. t. 6, p. 170.

the various types of implements found in them, proposed by M. de Mortillet, seems to be equally unsatisfactory; for there is no greater difference in the implements of any two of the palæolithic caves, than is to be observed between those of two different tribes of Eskimos, while the general resemblance is most striking. The principle of classification by the relative rudeness, assumes that the progress of man has been gradual, and that the ruder implements are therefore the older. The difference, however, may have been due to different tribes, or families, having co-existed without intercourse with each other, as is now generally the case with savage communities; or to the supply of flint, chert, and other materials for cutting instruments, being greater in one region than in another.

Relation of Cave-dwellers to Eskimos.

Can these cave-dwellers be identified with any people now living on the face of the earth? or are they as completely without representatives as their extinct contemporaries, the mammoth and the woolly rhinoceros? Absolute certainty we cannot hope to obtain on the

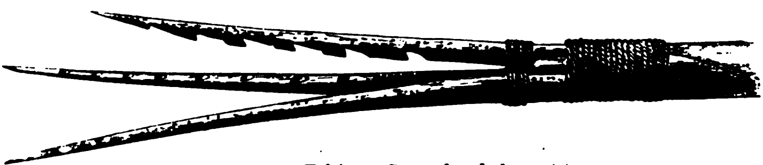


FIG. 122.—Eskimos Spear-head, bone (¼).

point, but the cumulative evidence enables an answer to be given which is probably true. Along the American shore of the great Arctic Ocean, in the region of everlasting snow, dwell the Eskimos, living by hunting and

FIG. 123.—Eskimos Arrow-straightener of Walrus Tooth (1/1). (Brit. Mus.)

fishing, speaking the same language, and using the same implements from the Straits of Behring on the west, to Greenland on the east. Their implements and weapons, brought home by the arctic explorers, enable us to institute a comparison with those found in the palæolithic caves. The harpoons in the Ashmolean collection at Oxford, brought over by Captain Beechey and Lieut. Harding from West Georgia, as well as those in the British Museum, are almost identical in shape and design with those from the caves of Aquitaine and Kent's Hole; the only difference being that some of the latter have grooved barbs. The heads of the fowling and fishing spears, darts, and arrows, as well as the form of their bases for insertion into the shafts, are also identical (Fig. 122), as may be seen from a comparison of Fig. 122 with Figs. 99 and 114. The

curiously carved instrument, Fig. 123, which the Eskimos use for straightening their arrows is variously ornamented with designs of animals, analogous to those cut on the reindeer antlers in Aquitaine; and if it be compared with the so-called "bâton de commandement," Fig. 121, it will be seen, that the latter also was probably intended for the same purpose; the difference in the shape of the hole in the two figured specimens being also observable in the series of Eskimos arrow-straighteners in the British Museum, and being largely due to friction by use. Many of the implements are the same in form. An Eskimos stone scraper for preparing skins, or plane for smoothing wood, is represented in Fig. 124, which is inserted in a handle of fossil mammoth ivory, obtained from the frozen ice-cliffs on the shores of the Arctic sea. If it be compared with Fig. 107 from the caves, it will be seen to be of the same pattern. It is indeed not a little singular, that the handle in which it is imbedded should have been formed out of the tusks of the same species of elephant as that which was depicted by the palæolithic hunter (see Fig. 120), in the south of France.

FIG. 124.—Eskimos Plane or Scraper (½). (Lartet and Christy.)

Some of the Eskimos lance-heads of stone in the British Museum are of the same type as that figured from the caves of the Dordogne (Fig. 108).

The most remarkable objects brought home from the northern regions are the implements of bone and antler which are ornamented with the figures of animals hunted by the Eskimos on sea or land. On the side of one bow in the Ashmolean Museum, used for drilling holes, you see them harpooning the whale from their skin boats, and catching birds. On a second they are harpooning walrus and catching seals; on a third the seals are being dragged home. The huts in which they live, the tethered dogs, the boat supported on its platform, and their daily occupations are faithfully represented. One bow is ornamented with a large number of porpoises, while on another is a reindeer hunt in which the animals are being attacked while they are crossing a ford. On a bone implement in the British Museum from Port Clarence, the reindeer are being shot down by archers (Fig. 125). The arrow straightener, Fig. 123, is adorned with a reindeer hunting scene, in which the animals are seen browsing and unsuspicious of the approach of the hunters, who are advancing, clad in reindeer skins and wearing antlers on their heads.

A comparison of these various designs with those from the caves of France and Belgium shows an identity of plan and workmanship, with this difference only, that the hunting scenes familiar to the palæolithic cave-dweller were not the same as those familiar to the Eskimos on the shores of the Arctic Ocean. Each sculptured the animals he knew, and the whale, walrus, and seal were unknown to the inland dwellers in Aquitaine, just as the mammoth, bison, and wild horse are unknown to the Eskimos. The reindeer, which they both knew, is represented in the same way by both. The West Georgians made their dirks of walrus tooth, and orna-

mented them with carvings of the backbones of fishes; the people of Aquitaine used for the same purpose reindeer antlers, and ornamented them with figures of that animal (see Fig. 116). And it is worthy of remark that the latter had sufficient artistic feeling to depict the mammoth on mammoth ivory, the reindeer generally on reindeer antler, and the stag on its own antler.

An appeal to the habits of these two peoples, now separated by so wide an interval of space and time, tends also to show that they are descended from the same stock. The method of accumulating large quantities of

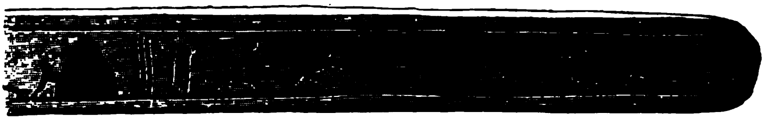


FIG. 125.—Eskimos Hunting-scene (½). (Fort Clarence.)

the bones of animals around their dwelling-places, and the habit of splitting the bones for the sake of the marrow, is the same in both. Their hides were prepared by the same sort of instruments and in the same manner, and the needles with which they were sewn together are of the same pattern. The few remains of man among the relics of feasts in the caves of Belgium and France, show the same disregard of sepulture as that implied by the human skulls lying about along with numerous bones of walrus, seal, dog, bear, and fox, in an Eskimos camp in Igloolik, which were carried away by Captain Lyon, without the slightest objection on the part of the relatives of the dead.

All these facts can hardly be mere coincidences, caused by both peoples leading a savage life under similar circumstances: they afford reasons for the belief that

the Eskimos of North America are connected by blood with the palæolithic cave-dwellers of Europe. To the objection that savage tribes living under similar conditions use similar instruments, and that, therefore, the correspondence of those of the Eskimos with those of the reindeer folk does not prove that they belong to the same race, the answer may be made, that there are no two savage tribes now living which use the same set of implements, without being connected by blood. The agreement of one or two of the more common and ruder instruments may be perhaps of no value in classification, but if a whole set agree, fitted for various uses, and some of them rising above the most common wants of savage life, we must admit that the argument as to race is of very great value. The implements found in Belgium, France, or Britain differ scarcely more from those now used in West Georgia, than the latter do from those now in use in Greenland or Melville Peninsula. The conclusion, therefore, seems inevitable, that so far as we have any evidence of the race to which the dwellers in the Dordogne belong, that evidence points only in the direction of the Eskimos.

This conclusion is to a great extent confirmed by a consideration of the animals found in the caves. The reindeer and the musk sheep afford food to the Eskimos now, just as they afforded it to the palæolithic hunters in Europe. No naturalist would deny that the pleistocene musk sheep is of the same species as that of North America, and although the animal is extinct in Europe and Asia, its remains, scattered through Germany, Russia in Europe, and Siberia, show that it formerly ranged in the whole of that area. The enormous distance, therefore, of southern France from the northern shores of America,

cannot be considered as an obstacle to this view, for, to say the least, palæolithic man would have had the same chance of retreating to the north-east as the musk sheep. The mammoth and bison have also been tracked by their remains in the frozen river gravels and morasses through Siberia, as far to the north-east as the American side of the Straits of Behring. Palæolithic man appeared in Europe with the arctic mammalia, lived in Europe along with them, and disappeared with them. And since his implements are of the same kind as those of the Eskimos, it may reasonably be concluded that he is represented at the present time by the Eskimos, for it is most improbable that the convergence of the ethnological, and zoological evidence should be an accident. These views,[1] which I advanced in 1866, have been to a great extent accepted by Sir John Lubbock in his last edition of Prehistoric Man.

Pleistocene Animals living to the North of the Alps and Pyrenees.

The principal mammalia inhabiting Britain, France, and Germany during the pleistocene age, and contemporary with man in Europe, are given in the following table, which shows that the fauna of the region to the north of the Alps and Pyrenees was remarkably uniform. The cave-fauna of Provence, Italy, and Spain, will be treated of in the next chapter.

[1] "Eskimos in the South of Gaul." Saturday Review, December 8th, 1866. Edinburgh Review, "Prehistoric Times." October 1870.

Species	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Homo palaeolithicus—Palaeolithic Man	×		×		×										×				×	×
Spermophilus citillus—Pouched Marmot																				
Arctomys marmotta—Common Marmot																				
Castor fiber—Beaver																				
Lepus timidus—Hare		×												×	×					
Lepus variabilis—Alpine Hare																				
Lepus cuniculus—Rabbit	×	×													×					
Lepus diluvianus—Extinct Hare																				
Lagomys pusillus—Tailless Hare																				
Mus lemmus—Lemming																				
Hystrix dorsata—Porcupine	×																			
Felis leo (var. spelaea)—Lion		×		×									×	×	×					×
Felis pardus—Leopard																				
Felis Lynx—Lynx																				
Felis caffer—Caffir Cat																				
Felis catus—Wild Cat	×												×		×					
Machairodus latidens																				
Gulo borealis—Glutton	×					×														
Hyaena crocuta (var. spelaea)—Spotted Hyaena	×	×	×	×		×	×	×	×	×		×	×	×	×	×	×	×	×	×
Hyaena striata—Striped Hyaena																				
Mustela martes—Marten													×	×	×					
Mustela putorius—Polecat									×					×	×					
Mustela erminea—Weasel		×							×											
Lutra vulgaris—Otter															×					
Ursus arctos — Brown Bear	×	×	×					?						×					×	
Ursus ferox — Grizzly Bear	×	×	×	×	×				×	×				×						
Ursus spelaeus — Cave-Bear	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×				×
Canis lupus—Wolf	×	×	×	×	×	×		×	×	×	×	×	×	×	×	×				
Canis vulpes—Fox	×	×	×	×	×	×		×	×	×	×	×	×	×	×					
Canis lagopus—Arctic Fox																				
Elephas primigenius—Mammoth	×		×					×					×	×	×	×	×	×		×
Elephas antiquus		×		×	×				×	×		×	×	×	×					
Elephas Africanus—African Elephant																				
Equus caballus—Horse	×	×	×	×		×		×					×	×	×		×	×		×
Rhinoceros tichorhinus—Woolly Rhinoceros	×		×	×										×	×	×	×	×		
Rhinoceros hemitoechus		×		×	×				×	×		×	×		×					
Rhinoceros megarhinus																				
Bos urus—Urus																				
Bos bison—Bison	×	×	×	×	×	×		×	×	×	×	×	×	×	×		×	×		×
Ovibos moschatus—Musk Sheep																				
Capra ibex—Ibex																				
Capella rupicapra—Chamois																				
Antilope saiga—Saiga																				
Sus scrofa—Wild Boar	×	×		×				×	×	×	×	×	×	×	×					
Cervus elaphus—Stag	×	×	×	×	×				×					×	×					
Cervus capreolus—Roe	×								×		×			×						×
Cervus megaceros—Irish Elk	×	×	×	×	×									×	×					×
Cervus tarandus—Reindeer	×	×	×	×	×	×	×	×	×	×	×			×	×	×	×	×		×
Hippopotamus amphibius (var. major) Hippopotamus		×		×	×								×							

Species.	Durdham.	Hutton.	Banwell.	Bleadon.	Uphill.	Sandford Hill.	Wookey Hole.	Brixham.	Kent's Hole.	Moustier.	La Madelaine.	Laugerie Haute.	Laugerie Basse.	Gorge d'Enfer.	Cro Magnon.	Les Eyzies.	Lunel Viel.	Belgian Caves.	River Deposits, Britain.	River Deposits, France.
Homo palæolithicus—Palæolithic Man							×	×	×	×	×	×	×	×	×	×		×	×	×
Spermophilus citillus—Pouched Marmot						×	×								×	×		×	×	
Arctomys marmotta—Common Marmot																		×		
Castor fiber—Beaver									×								×	×	×	×
Lepus timidus—Hare							×	×	×	×	×	×?	×?		×	×		×	×	×
Lepus variabilis—Alpine Hare																		×		
Lepus cuniculus—Rabbit								×	×		×				×					×
Lepus diluvianus—Extinct Hare							×										×	×		×
Lagomys pusillus—Tail-less Hare				×				×	×									×		
Mus lemmus—Lemming				×			×									×		×	×	
Hystrix dorsata—Porcupine																		×		
Felis leo (*var. spelæa*)—Lion	×	×	×	×	×	×	×	×	×					×	×	×	×	×	×	×
Felis pardus—Leopard		×	×	×													×			×
Felis lynx—Lynx			×															×		×
Felis caffer—Caffir Cat																	×	×		
Felis catus—Wild Cat				×	?				×								×	×	×	×
Machairodus latidens									×											
Gulo borealis—Glutton			×	×														×		
Hyæna crocuta (*var. spelæa*)—Spotted Hyæna	×	×	×	×	×	×	×	×	×	×							×	×	×	×
Hyæna striata—Striped Hyæna																	×			
Mustela martes—Marten				×																×
Mustela putorius—Pole-cat																		×		
Mustela erminea—Weasel									×									×	×	
Lutra vulgaris—Otter	×			×					×									×	×	
Ursus arctos—Brown Bear	×			×		×	×	×	×									×	×	×
Ursus ferox—Grizzly Bear			×				×	×	×									×	×	×
Ursus spelæus—Cave-Bear		×	×	×		×	×	×	×				×	×	×		×	×		(?)
Canis lupus—Wolf		×		×	×	×	×	×	×		×	×	×	×	×	×	×	×	×	×
Canis vulpes—Fox		×		×	×	×	×	×	×		×	×	×	×	×	×	×	×	×	×
Canis lagopus—Arctic Fox																		×		
Elephas primigenius—Mammoth	×	×	×	×		×	×	×	×	×	×	×	×		×	×		×	×	×
Elephas antiquus	×			×														×	×	×
Elephas Africanus—African Elephant																				
Equus caballus—Horse	×	×	×	×	×	×	×	×	×	×	×	×	×		×	×	×	×	×	×
Rhinoceros tichorhinus—Woolly Rhinoceros			×			×	×	×	×									×	×	×
Rhinoceros hemitœchus	×						×										×		×	
Rhinoceros megarhinus																			×	×
Bos urus—Urus			×	×		×	×	×	×								×	×	×	×
Bos bison—Bison		×	×	×	×	×	×		?	×	×	×	×	×	×	×		×	×	×
Ovibos moschatus—Musk Sheep											×			×					×	×
Capra Ibex—Ibex											×	×	×	×	×	×		×		×
Capella rupicapra—Chamois											×		×			×		×		×
Antilope saiga—Saiga													×			×		×		
Sus scrofa—Wild Boar		×		×	×		×		×		×				×		×	×	×	×
Cervus elaphus—Stag			×	×			×	×	×	×	×	×	×		×	×	×	×	×	×
Cervus capreolus—Roe				×				×										×	×	×
Cervus megaceros—Irish Elk		×	×	×			×		×			×						×	×	×
Cervus tarandus—Reindeer	×	×	×	×	×		×	×	×	×	×	+	×	+	×	×		×	×	×
Hippopotamus amphibius (*var. major*)—Hippopotamus	×								(?)										×	×

Cave Fauna the same as River-bed Fauna.

If this list[1] of animals from the caves be compared with that of the river-deposits of Britain and the continent, it will be seen that the same fauna is present in both, and that they are therefore of the same geological age.[2] This was the conclusion to which Dr. Falconer was led by the examination of the caves of Gower, and it has been confirmed by every subsequent discovery.

The Pleistocene Coast-line of North-Western Europe.

The identity of the British pleistocene fauna with that of the continent, leads to the conclusion that in the pleistocene age Britain was connected with the adjacent countries by a bridge of land, over which the wild animals had free means of migration. And this might be brought about by a comparatively small elevation of the area. The soundings show that Britain and Ireland constitute merely the uplands of a plateau now submerged to the extent of about 100 fathoms, on the side of the Atlantic. On the east it extends at a depth of from twenty to fifty fathoms, in the direction of Belgium; and on the south it is only sunk from twenty to forty fathoms below the sea-level. Immediately to the westward of this line the sea deepens so suddenly, that there is scarcely any difference between the lines of 100 and of 200

[1] The authorities for the foreign lists of animals will be found in the "Quart. Geol. Journ." 1872, p. 424. The British animals have been determined principally by myself and Dr. Falconer.

[2] "Classification of the Pleistocene Strata," Quart. Geol. Journ. Nov. 1872, p. 410.

fathoms, and the depth rapidly increases to 2,000. Were

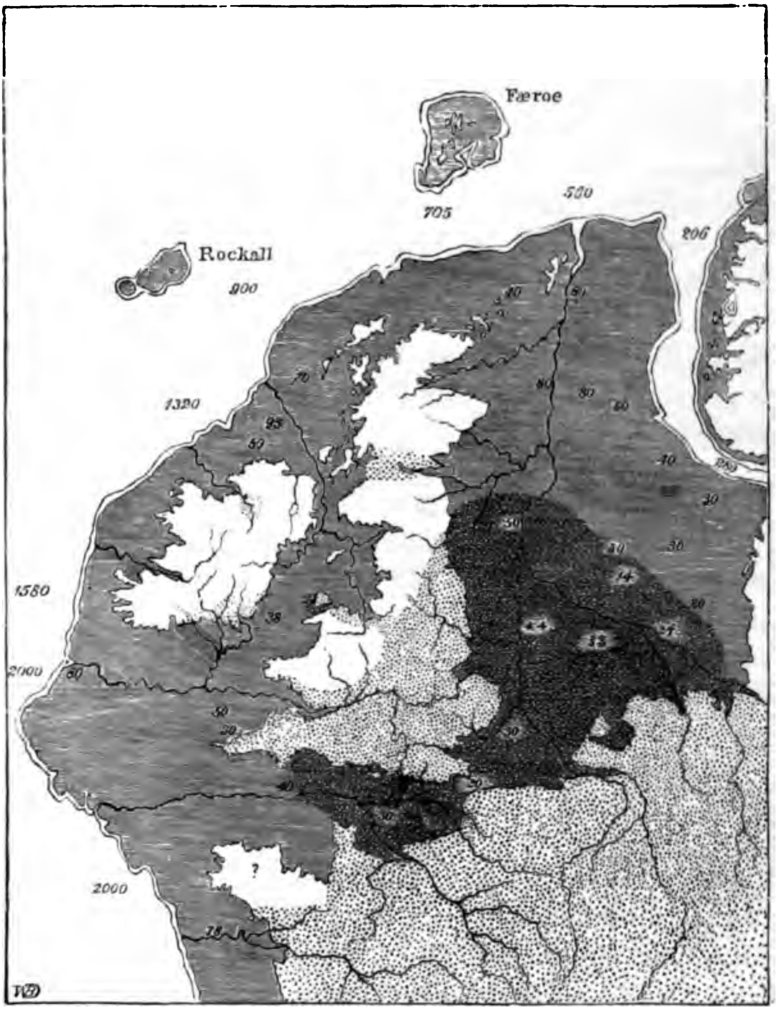


FIG. 126.—Physiography of Great Britain in Late Pleistocene Age.
Shaded area = land now submerged; dotted area = region occupied by animals; plain area = region occupied by glaciers.

this plateau elevated above the sea to an extent of 100

fathoms, the tract shaded in the map (Fig. 126) would unite the British Isles to the continent, and the Thames and other rivers on the eastern coast would unite with the Elbe and the Rhine to form a river debouching on the North Sea, somewhat after the manner which I have represented by taking the deepest line of soundings. The Straits of Dover would then be the watershed between this valley of the German Ocean, as it may be termed, and that of the English Channel, in which the Seine and the Somme and other French rivers joined those of the south coast, and ultimately reached the Atlantic. Evidence that the latter river flowed in the course assigned to it in the map is afforded by the discovery of the fresh-water mussel (*Unio pictorum*), recorded by Mr. Godwin Austen[1] to have been dredged up by Captain White from a depth of from 50 to 100 fathoms, not very far from what I have taken to be its mouth. We are also indebted to Mr. Godwin Austen for the discovery near this spot of banks of shingle and littoral shells, which indicate the position of the ancient coast-line.

The view that the 100-fathom line marks the limit of the pleistocene land surface to the west, is held by Sir H. de la Bêche, Mr. Godwin Austen, Sir Charles Lyell, and other eminent geologists, and it is supported by many facts that can be explained in no other manner. To pass over the discovery of a fresh-water shell at the bottom of the English Channel, quoted above, the distribution of fossil mammalia at the bottom of the German Ocean (represented in Fig. 126 by the dotted area) is

[1] Godwin Austen, "Quart. Geol. Journ." vol. i. p. 69. De la Bêche, "Theoretical Researches," p. 190. Lyell, "Antiquity of Man," 4th edit. p. 328.

analogous to that which we find in the river gravels and brick-earths on the land. The quantity of teeth and bones belonging to the mammoth, woolly rhinoceros, horse, reindeer, and spotted hyæna, and other animals, dredged up by the fishermen in the German Ocean is almost incredible. Mr. Owles, of Yarmouth, informed me in 1868 that off that place there is a bank on which the fishing nets are rarely cast without bringing up fossil remains. It seems most probable, that these accumulations have been formed under subaerial conditions near the drinking places, or below the fords, which were used for ages by the pleistocene animals. I might quote as an example of a similar deposit of fossils on the land, that discovered in 1866 by Captain Luard, R.E., in digging the foundations of the new cavalry barracks at Windsor, which consisted mainly of bones and antlers of reindeer, with a few carnivores, such as the brown bear and wolf, that usually follow reindeer in their migrations in Siberia.[1] Were this submerged it would be a case precisely similar to that off Yarmouth.

The ancient forest, exposed at low water under the cliffs on the Norfolk and Suffolk shores, flourished when the land stood higher than it does now. Traces of a similar forest, also at, and below, low-water mark, have been met with on the shore at Selsea, near Chichester, in Sussex; and remains of the mammoth have been dredged up in several places off the coast, as for example in Torbay and in Holyhead harbour, or found in gravel beds near low-water mark, as in the Isle of Wight, and on the north coast of Somerset at St. Audries, near Watchet, where a skull with gigantic tusks rested in the

[1] The accumulation of the remains of reindeer in the limited area of the excavation was enormous.

gravel. In all these facts we have ample proof that Britain stood at a higher level in the pleistocene age than at the present day.

The vast abundance also of the mammalia in the caves of South Wales and Somerset, and their presence in the Island of Caldy, and it may be added in Ireland, can only be accounted for by the elevation of the present sea-bottom, so as to allow of their migration over plains covered with abundant pasture. It seems, therefore, to me that the accompanying map, Fig. 126, represents with tolerable accuracy the ancient coast-line of Britain, and of the adjacent parts of the continent in the pleistocene age. The fertile valleys of the English Channel, Bristol Channel, and the German Ocean, would afford sustenance to a large and varied fauna, and numerous herbivores, such as the reindeer, bison, and horse, would supply food to the palæolithic hunters, who followed them in their annual migrations. And it must be remarked on this hypothesis, that the valley of the Garonne would offer a free passage both to the animals and to the hunters of Auvergne down to the prairie, extending as far as the 100-fathom line off the French coast, and that the hunting grounds would reach to Devonshire and Somerset without any barrier except that offered by the rivers. It is therefore no wonder that the implements in the caves of Kent's Hole, Wookey Hole, and the South of France, should be of the same type.

Distribution of Palæolithic Implements in this Area.

This geographical configuration in pleistocene times may perhaps account for the distribution of the palæolithic implements in the river gravels. The Seine and

the Somme debouch into the same valley as the rivers of the south of England, and the Straits of Dover mark the position of a low watershed leading into the valley of the German Ocean, on the sides of which, in the eastern counties, river-bed implements are so numerous. These are of the same type in northern France, Sussex, Hampshire, Kent, and as far north as the Wash; and were therefore used by the same race of men. The difference between them and those of the cave-dwellers in the south and west, may be due to their possessors occupying different hunting grounds. Each tribe of American Indians at the present time has its own territory for hunting, which is jealously guarded against encroachment, and in which the articles peculiar to the tribe are being accumulated in the refuse-heaps, while other sets are being accumulated in other districts. If we suppose that the palæolithic savages divided up their hunting grounds in this manner, the difference which exists between the implements of the river-beds and caves may be readily explained, as well as their being found for the most part in different areas.

The pleistocene climate in the area north of the Alps and Pyrenees will be treated in the eleventh chapter, after the examination of the cave-fauna of southern Europe.

CHAPTER X.

THE FAUNA OF THE CAVES OF SOUTHERN EUROPE AND THE EVIDENCE AS TO THE MEDITERRANEAN COAST-LINE IN THE PLEISTOCENE AGE.

Changes of Level in the Mediterranean area in Meiocene and Pleiocene Ages.—Bone-caves of Southern Europe.—Of Gibraltar.—Of Provence and Mentone.—Of Sicily.—Of Malta.—Range of Pigmy Hippopotamus.—Fossil Mammalia in Algeria.—Living Species common to Europe and Africa.—Evidence of Soundings.—The Glaciers of Lebanon.—Of Anatolia.—Of Atlas.—Glaciers probably produced by elevation above the Sea.—Mediterranean Coast-line comparatively modern.

In the preceding chapter we have seen that north-western Europe was elevated, during the pleistocene age, to an extent of at least 600 feet above its present level; so that Ireland was united to Britain, and Britain was joined to the mainland of Europe, proof of this elevation being dependent upon the soundings on one hand, and the distribution of the fossil mammalia on the other. Such a change must necessarily have affected the whole physical conditions of the area, since the substitution of a mass of land for a stretch of sea, and the higher altitude of the land, would tend to produce climatal extremes of considerable severity. It is indeed no wonder that during this time of continental elevation, the hills of

Wales, Yorkshire, Derbyshire, Cumbria, and Scotland should be crowned with glaciers, or that there should have been a migration to and fro of animals, comparable to that which is now going on in Siberia and the northern portions of North America. The condition of southern Europe at that time has a most important bearing on any conclusion which may be drawn as to the pleistocene climate in France, Germany, or Britain. For if it be proved that the Mediterranean Sea was then smaller than it is now, the greater land-surface would increase both the heat of the summer and the cold of the winter in central and north-western Europe.

Changes of Level in Mediterranean area in Meiocene and Pleiocene Ages.

The geological evidence that the Mediterranean region has been subjected to oscillations of level during the tertiary period, is clear and decisive. Prof. Gaudry[1] has proved, in his work on the fossil remains found at Pikermi, that the plains of Marathon, now so restricted, must have extended in the meiocene age far south into the Mediterranean, so as to afford pasture to the enormous troops of hipparions and herds of antelopes, the mastodons and large edentata, revealed by his enterprise. The rocky area of Attica, as now constituted, could not have supported such a large and varied group of animals, nor could the broken hills and limestone plateaux have been inhabited by hipparions and antelopes, if their habits at all resembled those of their descendants living at the present time. It may, therefore, reasonably be concluded

[1] "Les Oss. Foss. de Pikermi," 4to.

that Greece, in those times, was prolonged southwards, and united to the islands of the Archipelago by a stretch of land. If Africa were then as now the head-quarters of the antelopes, it is very probable that one of the lines by which they passed over into Europe, and spread over France and Germany, was in this direction. Nevertheless, it must be admitted that the changes of level, which have taken place since the meiocene age in those regions, are so complicated as to render it almost impossible to restore the meiocene geography.

In the succeeding, or the pleiocene age, the presence of the African hippopotamus in Italy, France, and Germany, can only be accounted for by a more direct connection with the African mainland than is offered by a route through Asia Minor. It would seem, therefore, that the Mediterranean Sea could not then have formed the same barrier to the northern migration of the animals which it does now. In many regions, however, the present land was then sunk beneath the sea, and marine strata, of pleiocene age, were accumulated in the Val d'Arno, Sicily, and southern France.

The physical geography [1] of the Mediterranean in the pleistocene age may be ascertained with considerable accuracy by the distribution of the animals, coupled with the evidence of the soundings.

Bone-caves of Southern Europe.

The mammalia in the bone-caves of southern Europe differ from those of the region north of the Alps and Pyrenees in the absence of the arctic species, and the

[1] Some parts of the rest of this chapter have been published in the "Popular Science Review," March 1873.

presence of some which are of a more strictly southern type. Nevertheless, the influence of the mountains in lowering the temperature in their neighbourhood is to be traced in the presence of the remains of certain animals. Thus, in the caves of Gibraltar we find an ibex, which cannot be distinguished from those of the Spanish sierras, and in Mentone and Provence, a marmot, specifically identical with that of the Alps.

The bone-caves in the neighbourhood of the Mediterranean afford most important testimony as to the geographical changes which have taken place, since the animals found in them lived in that region. We will take those of the Iberian peninsula first.

Caves of Gibraltar.

Ossiferous caverns have long been known to occur in the fortified rock of Gibraltar,[1] but were not examined scientifically until the year 1863, when the researches of Captain Brome, Prof. Busk, and Dr. Falconer, proved that pleistocene species were buried in considerable numbers in its cavities and fissures. Of these the most important is the great perpendicular fissure in Windmill Hill, called the Genista cave, which has been traced down to more than a depth of 200 feet. From the upper portion were obtained the polished stone implements, human skulls, and other neolithic remains described in the sixth chapter, p. 204, which prove that Gibraltar was inhabited by the Basques in the neolithic age, while the remains from the lower revealed the presence of a singularly mixed group of animals.

[1] "Palæontographical Memoirs," vol. ii. p. 554. Busk, Prehistoric Congress, Norwich volume, 1869.

The fossil bones have been referred by Prof. Busk and Dr. Falconer to the following species:—

Lepus cuniculus, rabbit.	*Equus caballus*, horse.
Felis leo, lion.	*Rhinoceros hemitœchus.*
F. pardus, panther.	*Capra ibex*, ibex.
F. caffer.	*Sus scrofa*, wild-boar.
F. pardina, lynx.	*Cervus elaphus*, red deer.
F. serval, serval.	*C. capreolus*, roe.
Ursus ferox, grizzly bear.	*C. dama*, fallow deer.
Canis lupus, wolf.	

The spotted hyæna, the serval, and *Felis caffer*, are species now peculiar to Africa, and it is obvious that they could not have found their way into Gibraltar under the present physical conditions of the Mediterranean. Elephants and rhinoceroses could not have lived on so barren and treeless a rock, unless it had overlooked a fertile plain, nor would the carnivora have chosen it for their dens, had it then been cut off from the feeding-grounds of the herbivores. Their presence, therefore, as Dr. Falconer justly remarks, implies the existence of land now sunk beneath the waves, but then extending southwards to join Africa.

To the African animals, mentioned above as inhabiting the Iberian peninsula in the pleistocene age, M. Lartet has added the African elephant (*E. Africanus*) and the striped hyæna (*H. striata*), which have been found in a stratum of gravel near Madrid along with flint implements.[1] None of the purely arctic mammalia, such as the reindeer, musk sheep, or woolly rhinoceros, so abundant in France, Germany, and Britain, have been met with south of the Pyrenees.

[1] "Comptes Rendus," xlvi. 1858.

Bone-caves of Provence and Mentone.

The arctic animals are also absent from the numerous bone-caves and bone breccias of Provence and Mentone. The pleistocene fauna of Provence consists, according to M. Marion,[1] of the spotted hyæna, and lion, *Elephas antiquus* or straight-tusked elephant, *Rhinoceros hemitœchus*, wild-boar, urus, stag, horse, and rabbit. The breccias in the island of Ratonneau have also furnished the porcupine, brown bear, and tailless hare. Man is proved to have been living in the district at the time by the discovery of perforated and cut bones, in the cave of Rians.

The fissures and caves of Mentone, explored by Mr. Moggridge[2] in 1871, and subsequently by M. Rivière, contained a fauna composed, according to Prof. Busk, of the following species:—

Marmot.	Brown bear.
Field-vole.	Cave-bear.
Lion.	Roe.
Panther.	Stag.
Lynx.	Ibex.
Wild-cat.	Urus.
Spotted hyæna.	Horse.
Wolf.	Wild-boar.
Fox.	*Rhinoceros hemitœchus.*

Along with these were large quantities of charcoal and flint flakes, which proved that man had inhabited the district while the deposits were being formed.

[1] Prehistoric Congress, Paris volume, p. 96.
[2] "Brit. Ass. Reports," Edinburgh, 1871.

Mr. Moggridge gives the following account of the results of his exploration:—[1]

"The caves of the red rocks, half a mile out of Mentone, are in lofty rocks of jurassic limestone on the shore of the Mediterranean, and at an average height of 100 feet above that sea, the rocks themselves attaining an elevation of 260 feet. They have now been repeatedly rifled by the learned or the curious; but when the principal cave (Cavillon) was nearly intact, the author made a section of it from the modern or highest floor, down to the solid rock. There were five floors formed in the earth by long-continued trampling; on each, and near the centre, were marks of fire, around which broken bones and flints were abundant, except upon the lowest, where but few bones occurred, and no flints. The bones were those of animals still existing. Few implements were found, but many chips of flint, some cores and stones used as hammers. Perhaps this cave was used as a place for manufacturing flints, which must have been carried from their native bed, distant about one mile.

"There is nothing to evince the action of water; on the contrary, the numerous stones that occur are all angular . . . . Below these caves a slope of about 180 feet descends to the edge of the sea. Through the upper part of this slope, at distances from the cave of from 0 to ten feet, is a railway cutting 600 feet long, fifty-four feet deep, and sixty feet above the sea. The mass removed in making this cutting was composed of angular stones not waterworn. Loose at the surface, it soon became a more or less mature breccia, for the most part so hard that it was blasted with gunpowder." In this breccia, and at various depths, some of more than thirty

[1] "Brit. Assoc. Rep." 1871.

feet, the author has taken out teeth of the bear (*Ursus spelæus*) and of the hyæna (*Hyæna spelæa*) while with and below those teeth he found flints worked by man.

The subsequent exploration by M. Rivière[1] has resulted in no important addition to the fauna: the famous human skeleton having been, as I have already remarked in the seventh chapter, interred in the pleistocene strata, and probably not palæolithic. It may possibly be of the era of the upper floors described by Mr. Moggridge, in which all the remains belong to living species.[2]

This cave-fauna is more closely related to that of southern Europe than to that north of the Alps and Pyrenees. The striped hyæna found in the cave of Lunel-viel, Hérault, by Marcel de Serres, along with the reindeer and other animals, probably belongs to the same southern group.

Bone-caves of Sicily.

Certain members of the African fauna are also proved to have ranged northwards over Europe in the direction of Sicily, by the discoveries in the caves of that island. The Sicilian bone-caves have been worked for the sake

[1] *Découverte d'une Squelette Humaine de l'époque Paléolithique dans les Cavernes de Baoussé-Roussé, dites Grottes de Menton*, 1873; also Prehistoric Congress, Brussels volume. M. Rivière adds the Wapiti, or large variety, and the *Cervus Corsicanus*, or small variety of the stag, the chamois, and the woolly rhinoceros (the two last of which may be perhaps identical with the ibex and *R. hemitœchus*, determined by Prof. Busk, as neither is mentioned by M. Rivière), and the *Capra primigenia* of Gervais, a large goat commonly found in neolithic caves.

[2] The depth at which the skeleton was found is a matter of dispute, the estimates varying from seven feet (Pengelly) to (6·55 m.) 21·49 feet (Rivière). Pengelly, *Cave man of Mentone*, "Trans. Devon Ass." 1873, pp. 10 and 13.

of the bones since the year 1829; and of these many shiploads were sent to Marseilles from San Ciro, belonging, according to M. de Christol, principally to the hippopotamus. In 1859,[1] Dr. Falconer examined the collections made from this cave, as well as those which remained *in situ*, and carried on further researches into a second in the neighbourhood, known as the Grotto di Maccagnone, and in the following year two others were discovered and explored in northern Sicily by Baron Anca. The species were as follows:—

Homo, man.
Felis leo, lion.
Hyæna crocuta, spotted hyæna.
Ursus ferox,[2] grizzly bear.
Canis.
Cervus, deer.
Bos, ox.
Equus, horse.
Sus scrofa, boar.
Elephas antiquus.
Elephas Africanus, African elephant.
Hippopotamus major, hippopotamus.
Hippopotamus Pentlandi.
Lepus.

The presence of man was indicated by charcoal and flint flakes.

The African elephant was obtained from three caves: from that of San Teodoro, by Baron Anca; from Grotta Santa, near Syracuse, by the Canon Alessi; and from a cave near Palermo, by M. Charles Gaudin. It is obvious that the presence of this animal, as well as of the spotted hyæna, in Sicily can only be accounted for on the hypothesis that a bridge of land formerly existed, by which they could pass from their head-quarters, that is to say Africa. On the other hand the presence of the grizzly bear, and of the *Elephas antiquus* implies that they

[1] "Palæont. Mem." ii. p. 543.
[2] It is of the same species as the bear from Grays Thurrock.

passed over into Sicily, from their European head-quarters, before the existence of the Straits of Messina, since both animals are abundant on the mainland of Europe. The larger species of hippopotamus, doubtfully referred by Dr. Falconer to the *H. major* (= *H. amphi-*

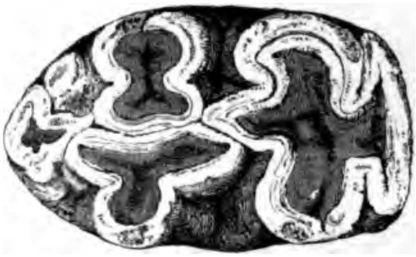


FIG. 127.—Molar of *Hippopotamus Pentlandi* (½). (Sicily.)

bius), may have crossed over either from Italy, where its remains are very abundant in the pleiocene and pleistocene strata, or from Africa.

A small species of hippopotamus, *H. Pentlandi*, Fig. 127, occurs in incredible abundance in the Sicilian caves. It bears the same relation, in point of size, to the fossil variety of the African hippopotamus, as the living *H. liberiensis* does to the latter.

Bone-caves of Malta.

The bone-caves of Malta were first scientifically explored by Admiral Spratt, in 1858, and subsequently by Dr. Leith Adams, and others. The Maghlak Cave near the town of Crendi, contained large quantities of the *Hippopotamus Pentlandi*, together with the gigantic dormouse, named *Myoxus Melitensis*. A short distance off a second cavern, explored by Dr. Leith Adams, contained numerous remains of at least two species of pigmy

elephant about the height of a small horse. Its small size may be gathered from the accompanying woodcut (Fig. 128) of the last lower true molar, taken from the litho-

Fig. 128.—Molar of *Elephas Melitensis*, Malta ($\frac{2}{3}$). (Falconer.)

graph published in Dr. Falconer's "Palæontographical Memoirs," vol. ii. pl. xii.

Range of Pigmy Hippopotamus.

The pigmy hippopotamus has lived also in other districts in the Mediterranean region. One of its teeth, now preserved in the British Museum, was discovered by Dr. Leith Adams, in Candia. In 1872 I identified in the Oxford Museum a last lower true molar, which extends the range of this species to the mainland of Europe. It was obtained by Dr. Rolleston from a Greek tomb at Megalopolis, in the Peloponese, and was probably derived from one of the many caves in the limestone of that district. For this extinct animal to have spread from Sicily to Malta, from Malta to Candia, and from Candia to the Peloponese, or vice versâ, these three islands must have been united to the Peloponese and have been the higher grounds of land, now submerged beneath the waves of the Mediterranean.

The view therefore, advanced by Dr. Falconer and Admiral Spratt, that Europe was connected with Africa

by a bridge of land, extending northwards from Sicily, is fully borne out by an examination of the fossil remains both of that island and of Malta (see Fig. 129).[1]

Fossil Mammalia in Algeria.

If the African mainland extended to Europe in the direction of the Straits of Gibraltar, and of Malta and Sicily, so as to afford passage for the African mammalia into Europe, it would equally afford passage for the southern advance into Africa of some of the European mammalia. Evidence of this we meet with in a stratum of clay at Mansourah, near Constantine, in Algeria, described by M. Bayle in 1854.[2] The animals which he obtained, consisting of the ox, antelope, hippopotamus, and elephant, have been described by Prof. Gervais. An examination of his figure of a fragment of a molar tooth leaves no room for doubt, that the *Elephas meridionalis* was living in north Africa during the pleistocene age; that is to say an extinct animal, the head-quarters of which are to be found in Italy, ranged as far south as northern Africa.

Living Species common to Europe and Africa.

The former continuity of Africa by way of the Iberian peninsula and Sicily, may also be inferred by the distribution of the mammalia at the present time. Prof. Gervais[3] observes that most of the insectivora are

[1] Falconer, "Palæont. Mem." vol. ii. p. 552. Spratt, "Quart. Geol. Journ." xxiii. p. 293.

[2] "Bull. Soc. Géol. Fr." 2e sér. t. xi. p. 340.

[3] Gervais, "Animaux Vertébrés Vivants et Fossiles," 4to. p. 88.

[illegible] Europe and north Africa. The genetic and [illegible] The Mangousta Widdringtoni [illegible] are common to Spain [illegible] The porcupine of Algeria belongs to the same species as that of Italy and Sicily, and the wild [illegible] present any characters of importance by which [illegible] separated from that of Europe. From the present range, therefore, of the mammalia the same [illegible] may be drawn as to the community of Africa with Europe as is afforded by their distribution in the [illegible]

Evidence of Soundings.

These conclusions derived from the study of the mammalia are confirmed and supplemented by the evidence of the soundings. As we enter the Straits of [illegible] the Atlantic Ocean shallows, until [illegible] it is not more than from [illegible] between Tarifa and Ceuta the [illegible] 400 fathoms, and thence, in [illegible] deepens to the extent of over 1,5[illegible] fathoms. An elevation of 400 fathoms would be quite sufficient to raise a barrier of land between Morocco and Spain, and to insulate the deep Mediterranean basin from the Atlantic. The soundings between Sicily and Tunis are 260 fathoms; between the former place and Malta, 55 fathoms; between Malta and the African mainland, 344 fathoms. An elevation of 400 fathoms would suffice therefore to connect Africa with Sicily, and to insulate the eastern from the western Mediterranean depths. To the east of Sicily the soundings reveal a depth of over 2,000 fathoms, and this deep

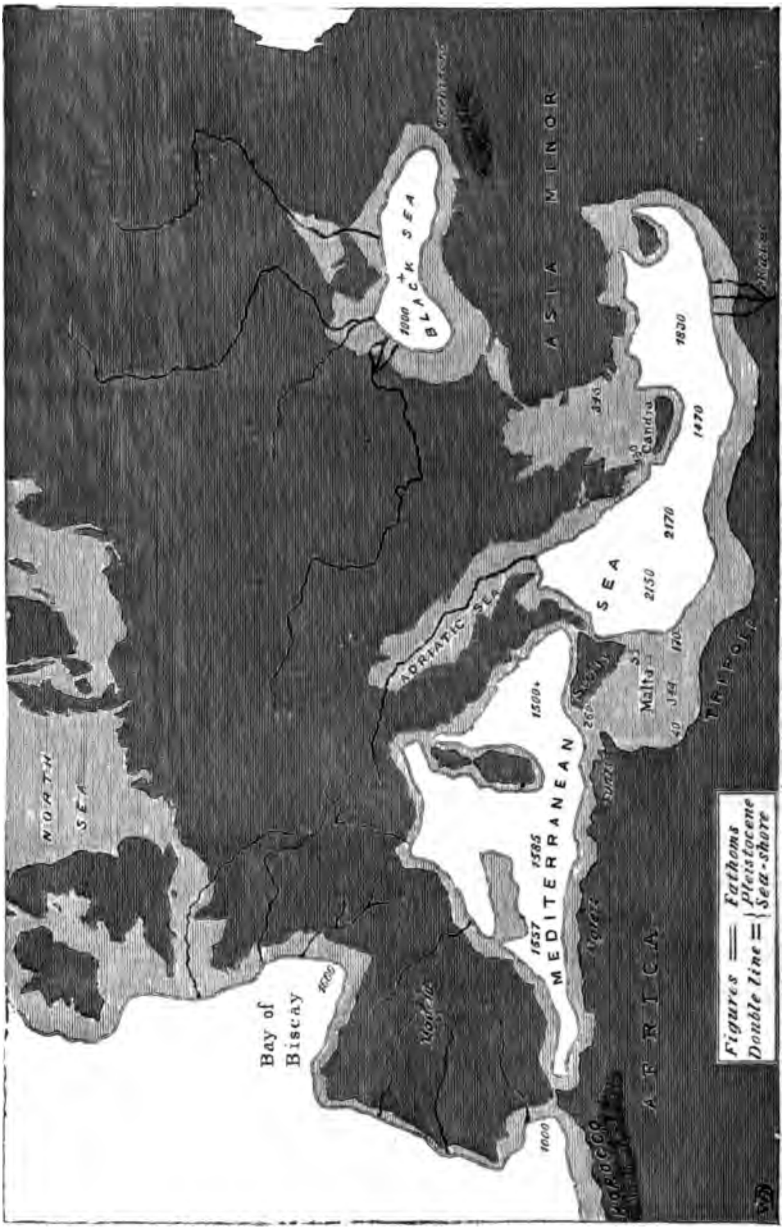


Fig. 129.—Physiography of Mediterranean in Pleistocene Age.

[illegible] as far as the [illegible] as Cyprus and Asia Minor. Between Candia and the Peloponnesus, the sea is 400 fathoms deep. An elevation therefore from 400 to 500 fathoms would allow of the passage of *Hippopotamus Pentlandi* from Candia to the Peloponnesus, and thence to southern Italy and Sicily and Malta. I have therefore represented in the map what would be the necessary result of the elevation of the bottom of the Mediterranean to that extent. Two great barriers of land would unite Africa with Spain and Italy, and enable the African mammalia to find their way into the regions north of the Mediterranean Sea. The shallowness of the sea at these two points indicates the existence of the ancient barriers. The African elephant however did not pass far northwards, since it has only been met with in Spain and Sicily.

Such a change in level as this would convert the Aegean into dry land, and cause the islands of the Grecian Archipelago to rise high above the surrounding plain. The 300-fathom line is therefore taken to represent the probable sea margin of the pleistocene age, although in centres of volcanic activity, such as Sicily and the Archipelago, local changes of level, even of greater magnitude, may have taken place.

This view of the former elevation of the Mediterranean area to a height of from two to three thousand feet above the present level will go far to explain the remarkable traces of glaciers discovered in Syria, Anatolia, and Morocco.

The Glaciers of Lebanon.

Dr. Hooker, in his journey to Syria in 1860, discovered that the cedars of Lebanon grew principally on one

spot, on old moraines which traverse the head of the Kedisha valley. This valley terminates in broad, shallow, open basins at a height of about 6,000 feet above the sea, resembling the corries of the Highlands; and one of these, in which the cedars grew, was divided into two distinct flats by a transverse range of ancient moraines from 80 to 100 feet high and with perfectly defined boundaries. "The rills from the surrounding heights collect in the upper flat, and form one stream, which winds among the moraines on its way down to the lower flat, whence it is precipitated into the gorge of the Kedisha. The cedars grow on that portion of the moraine which immediately borders this stream, and nowhere else; they form one group about 400 yards in diameter, with an outstanding tree or two not far from the rest, and appear as a black speck in the great area of the corry and its moraines, which contain no other arborious vegetation, nor any shrubs, but a few berberry and rose bushes that form no feature in the landscape." [1]

In ancient times, therefore, the glaciers descended to a height of about 6,000 feet above the sea, and were fed by the perennial snow-fields of the crest of Lebanon.

The Glaciers of Anatolia.

The former presence of glaciers at nearly the same altitude has also been proved by the travels of Mr. Gifford Palgrave in Anatolia,[2] especially in the valley through which the Chorok flows, and in the mountainous country to the north-east, between Georgia and the

[1] Hooker, "Nat. Hist. Review," II. p. 12, 1861.
[2] *Nature*, vol. v. p. 444; vol. vi. 536.

Black Sea. The river Chorok runs about 120 miles in a north-easterly direction, and is separated from the Euxine by a mountain chain reaching a height of 11,000 feet, thus forming a long strip of land, which is called Lazistan after its inhabitants, a tribe of Lazes. It then turns suddenly to the north, where it falls into the sea. The southern side is determined by mountains of Cretaceous, Jurassic, and Plutonic rocks, which form the watershed between the tributaries of the Black Sea and Persian Gulf. Three large moraines are to be found on the southern side of the valley, their lower extremity about 5,000, their upper origin nearly 8,000 feet above the sea. No moraines are seen where the chain does not reach an altitude of 7,000 feet, though angular boulders are not uncommon. The upper mountain contours are invariably rounded, and smoothed off, and the sides are scooped too widely for the depressions to have been caused by water. Low down in the valley the slopes terminate in rifted precipices.

That these moraines were posterior to the volcanic eruptions in the district, is evident from the examination of a broad stone ridge, near the highest point to the east of Erzeroum, where at a height of 7,000 feet the Jurassic limestone was interrupted by a volcanic outbreak of several miles in extent. Traces of a crater were visible. Above, the granite peaks rose to a height of 9,000 feet; below, a wide moraine crossed the road, composed of volcanic fragments mixed with granite. Consequently, it must have been formed after the volcano had become extinct. Similar traces are to be found at Keskeem Boughaz. Mr. Palgrave concludes "that the ice-cap of the north-eastern Anatolian watershed, in post-pleiocene (pleistocene) times, must have reached downwards, on

the northern side of the range, to 7,000 feet above the present sea-level, while some of the glaciers issuing from it descended to about 4,500 of the same measurement." Striated and ice-worn boulders, especially of granite, were very abundant. This region, it must be observed, is within sight of the lofty granite range of Tortoom, which is "streaked with perpetual snow."

After leaving the Chorok valley and getting on to the watershed, at a distance of fifty miles to the north-east, Mr. Palgrave reached the main ridge or backbone of the land. Here, among the limestone ledges, about 6,400 feet above the sea, is a colossal moraine, formed of worn granite blocks, partly overgrown with forest, and descending from a height of over 8,000 feet. It is divided, by a valley, from a lofty undulating granite plateau that is scooped out here and there into deep oval lakes, always full of blue water. The sides of the plateau are strewn with boulders of granite, brought from the higher peaks about five miles off. These boulders occur in greater or less abundance down to the basin of the Ardahan, near the sources of the Kur or Cyras, which joins the Araxes before flowing into the Caspian. The height of this Ardahan basin is about 6,500 feet; it is, but for a slight easterly slope, a water level. The bottom consists of deep alluvial soil mixed with detritus and boulders; the sides are rounded and smoothed, and bear every mark of long ice-covering. These plateaux, studded with lakes, stretch east to Russo-Georgia, till their greatest height is gained at Kel Dagh, a mountain about 11,000 feet high: thence they descend to the plains of Georgia and the Black Sea.

No glacial marks have been observed on the sea-ward side of the range, except at Hamshun in the Lazistan

mountains, between the River Kam and Tschimel Hem, at 6,900 feet, in a granite-strewn plateau, thinly green with grass, sheltered from the sea by lofty peaks on the north-west, and backed to the south-east by tremendous jagged granite cliffs, the highest 12,500 feet above the sea. "The plateau itself is about forty miles in length, irregular in breadth, its surface rounded and jotted over with boulders. But just as my track led near under the base of Verchembek, at an altitude of 8,300 feet, it crossed a large broad moraine," descending from the higher slopes, and having its base in a broad bare valley not far below, which showed that here, at the highest and widest part of the Lazistan chain, perpetual ice had once existed in sufficient quantity to furnish at least one glacier. From this case it seems that the limited ice-cap of the Hamshun highlands extended no further down than 8,500 or 9,000 feet, or from 1,000 to 2,000 feet lower than the glacial covering of the inland range.

The Glaciers of the Atlas Mountains.

Similar traces of glaciers have been observed in the Atlas mountains by Mr. George Maw,[1] in his travels in Morocco with Dr. Hooker and Mr. Ball in 1871. "After four hours' continued ascent," he writes (p. 19), "the termination of the glen comes into full view, and we observe with great interest that it is closed by a group of moraines, proving the former existence of glaciers in the Atlas, and confirming my opinion that the great boulder beds flanking the chain are also of

[1] "A Journey to Morocco, and the Ascent of the Great Atlas," 8vo. Slater, Troubridge, Salop.

glacial origin. Two villages, probably the highest in the Atlas, are built on the principal moraine; Eitmasan, at its base, at a height of 6,000 feet, and Arroond, near its summit, at a height of 6,800 feet; the terminal angle of the larger moraine having a vertical height of 800 feet. It is composed of immense blocks of porphyry, lying at a steep angle of repose, up which it takes us nearly an hour to climb. The existence of these moraines in latitude $30\frac{1}{2}°$ N. (the latitude of Alexandria) is perhaps the most interesting fact we noticed during our journey, for this is the most southerly point at which the evidence of extinct glaciers has been observed, and tends to confirm the opinion entertained by many geologists, that the refrigeration during the glacial period was almost universal."

Glaciers probably the result of elevation above the Sea.

The elevation of the African moraines above the sea, of about 6,000 feet and upwards, is nearly the same as those of Asia Minor. If the mountains of the Atlas, Lazistan, and Lebanon shared in the upward movement of the Mediterranean area, the addition of 3,000 feet to the height could not fail to leave marks behind of the low temperature thereby caused. It is very probable, that during the time the Mediterranean was reduced to two land-locked seas, these mountains were covered with snow-fields, and constituted the ice-sheds of glaciers.

From the range of the mammalia we have inferred the existence of land barriers, extending across from Africa to Spain and Italy, and from Candia to Greece, and their actual existence beneath the sea has been proved by

soundings, which necessitate an elevation of from 400 to 500 fathoms to bring them above the sea-level. We have also seen that the higher mountains, which most probably participated in this upward movement, bear traces of a lower temperature in the moraines of the Atlas and Lazistan. The hypothesis of such an elevation during the pleistocene age may therefore be taken to be proved so far as it explains two widely different classes of facts, the distribution of the mammals and the existence of glaciers where they are now unknown.

The physical condition of the Mediterranean area, in the pleistocene age, may be summed up as follows. The mainland of Africa extended northwards to join Europe, in the direction of Gibraltar and Italy. The islands of Malta and Sicily were hilly plateaux, overlooking an undulatory plain. Corsica and Sardinia were joined to Italy, Majorca and Minorca to Spain, Candia to Peloponese, and Cyprus to Asia Minor. The area now occupied by the Adriatic Sea constituted the lower valley of the Po, and the Archipelago was a plain studded with volcanic cones; and at the same time glaciers crowned the higher mountains of northern Africa and of Asia Minor.

The substitution of land for a stretch of sea, in the Mediterranean, could not fail to cause the summer heat to be more intense in the region to the north than at the present time, while the increased elevation would produce a greater severity of winter cold, as Mr. Godwin Austen has pointed out in the case of the hills of Devonshire. When, indeed, we consider that the pleistocene land surface extended from the snowy heights of Atlas, as far north as the 100-fathom line off the coast of Ireland, we might expect to find African animals, such as the spotted hyæna and *Felis caffer*, ranging as

far north as Yorkshire, for the only barrier to their migration would be that offered by the severity of a pleistocene winter.

Mediterranean Coast-line comparatively modern.

The submergence of the barriers, and the constitution of the Mediterranean as we find it now, have probably taken place but a short time ago, from the geological point of view, though we know that for the last 3,000 years the coast-line has been on the whole unchanged, except from the silting out of the sea by the sediment of rivers, such as the Po, and the elevation and depression of small areas by volcanic energy, as at Santorin. The physical character of the shores testifies to the truth of this view.

"On entering the Straits of Gibraltar," Mr. Maw writes, "from the Atlantic, a notable change takes place in the aspect of the coast. Cape St. Vincent, on the Atlantic coast, presents a bold line of cliffs to the sea, and bluff cliffs extend many miles towards the Straits; but as soon as these are passed, a change of coast-form takes place, which must be noticeable to every observer. Cliffs on the sea-board become the exception, and the general line of the coast is merely a shelving under the sea of the general hill-and-valley system of the land, the sea running up all the depressions, and the land elevations spreading out into the sea with scarcely any abrupt cliff-line of demarcation. The uneven sea-bottom of the Straits seems to be a continuation of the contour of the adjacent land, consisting of rolling alternations of hill and valley, which must have received its conformation by subaerial agencies."

[illegible] the sea [illegible] at the present level to excavate an [illegible]. The long alternating bays that occur along the coast from Marseilles to the Riviera suggest the same [illegible] the undulating land surface spreading [illegible] to the water's edge, and the deep bays running up the intervening valleys, which must have had an origin [illegible] that of their landward prolongations."

It is impossible to shut our eyes to the full force of this reasoning. The present aspect of the Mediterranean is, geologically speaking, a thing of yesterday.

Changes of Level in the Sahara coincident with those in the Mediterranean.

But if the Mediterranean area has been depressed to an amount of from 2,000 to 3,000 feet since the pleistocene age, we have proof that the region to the south has been elevated to that extent in comparatively modern times. Mr. Maw,[1] in his journey in 1873 to the Northern Sahara, observed raised beaches at a height of 2,000 feet, and loam and shingle-beds as high as 2,700 feet. He therefore concludes that the part of the Sahara which he explored had been raised at least 3,000 feet above the sea. These changes of level, the same in amount, but

[1] "Geological Notes on a Journey from Algiers to Morocco." Geol. Soc. Feb. 25, 1874.

in opposite directions, were probably compensatory and simultaneous. Northern Africa may have been cut off from the central and southern portions of the continent by the sea extending over the Sahara, during the time that the Mediterranean was represented by the two inland salt lakes figured in the accompanying map (Fig. 129). And while the region of the Sahara was being elevated, that of the Mediterranean was probably being depressed.

These changes in the relation of sea to land, and the greater elevation of the mountains in the neighbouring countries, must have affected not merely the climate of southern, but also of north-western Europe, and ought not to be left out of account in any theory relating to pleistocene climate.

CHAPTER XI.

THE EUROPEAN CLIMATE IN THE PLEISTOCENE AGE.

The evidence of the Mammalia as to Climate.—The Southern Group.—The Northern Group.—Probable cause of Association of Northern and Southern Groups.—The Temperate Group.—Species common to Cold and Tropical Climates.—Extinct Species.—Two Periods of Glaciation in Britain.—Three Climatal Changes represented on the Continent.—Europe invaded by Pleistocene Mammals before the Glacial Period.—Mammals lived in Britain during the Second Ice or Glacial Stage.—The Glacial Period does not separate one Life-era from another.—Relation of Palæolithic Man to Glacial Period.—Age of Contents of Caves in Glaciated Districts.

The Evidence of the Mammalia as to Climate.

In the last three chapters we have seen that the cave-mammalia throw great light on the pleistocene geography of Europe, and that there is reason for the belief that the land surface then extended northwards and westwards, so as to include Ireland; and southwards to join Africa, in the direction of Sicily, Malta, and Gibraltar. We must now pass on to the consideration of the climate on this great continental area, which would allow of so large and varied a fauna existing in our quarter of the world.

The Southern Group of Animals.

The pleistocene fauna is remarkable for the mixture of species. It consists of forms now banished to South Africa, Northern Asia, and America, or to the severe climate of high mountains, mingled with those which lived in Europe in the historic age, and those which have wholly disappeared from the face of the earth. We will take the living species first.

The southern group consists of the following animals:—

Lion.	Serval.
Caffir Cat.	Hippopotamus.
Spotted Hyæna.	African Elephant.
Striped Hyæna.	Porcupine.

At the present day the lion ranges over the whole of Africa, with the exception of Egypt and the Cape Colony, whence it has been driven out by the hand of man. In Asia, the maneless variety inhabits the valley of the Tigris and Euphrates, and the districts bordering on the Persian Gulf; and in India, according to Mr. Blyth, the province of Kattywar in Guzerat. Although now only found in these hot regions, it is proved, by the concurrent testimony of Herodotus, Aristotle, Xenophon, Ælian, and Pausanias, to have inhabited the mountains of Thrace, and of Asia Minor, and it probably became extinct in Europe before the end of the first century after Christ.[1] We may therefore infer that it possessed a sufficient elasticity of constitution to endure

[1] See "British Pleistocene Mammalia," Palæont. Soc. *Felis spelæa*, c. xviii.

[illegible]

[illegible] by the lion, was [illegible] spotted hyæna, it is very [illegible] an animal as the hippopotamus could have ranged from southern Europe, as far north as Yorkshire, under any other than temperate conditions. It could not have endured a winter sufficiently severe to cover the rivers with a thick coating of ice, without having its present habits profoundly modified; and such an alteration of habits would certainly leave its mark, in other modifications in the fossil skeleton than those minute differences which have been observed, when

it is compared with that of the living *Hippopotamus amphibius*. The porcupine of southern Europe has been found as far north as the caves of Belgium (Schmerling).

The Northern Group.

The northern group consists of those animals which are now only to be met with in the colder regions of the northern hemisphere, either in low latitudes or at great altitudes.

Marmot.	Arctic Fox.
Pouched Marmot.	Musk-sheep.
Lemming.	Reindeer.
Alpine Hare.	Ibex.
Tailless Hare.	Chamois.
Glutton.	

To this list the palæolithic man of the caves must be added, since he is probably related by blood to the Eskimos, and appeared in Europe simultaneously with the arctic group of animals.

The testimony of these animals as to climate is directly opposed to that of the preceding group, since they now only flourish in the arctic regions, or in mountainous districts in which the climate is severe. The marmot, in the pleistocene age, lived in Belgium, and descended from the Alpine heights as far as the shores of the Mediterranean, where it has been met with in the caverns near Nice. The pouched marmot, *Spermophilus citillus* of the Don and Volga, penetrated as far to the west as Somersetshire. The Alpine hare, now found only in the colder climates of northern Europe, Asia, and America (with the solitary exception of Ireland), ranged as far down the valley of the Rhine as Schussenreid, in Suabia. The two carnivores now dwelling in the colder

... wolverine, and the ... as far south as ... Schussenried, and both ... Germany, and of northern ...

... its habit of all ... present time, restricted to the ... it thrives in the ... being driven ... severity of the winter. ... remains, from its present ... and through the vast ... in Europe, Germany, ... as the barrier offered ... this large area its remains ... the reindeer, and both these ... were hunted by the ... Aquitaine, just as ... the shores of the

... animals be any index ... pleistocene age, their pre- ... Alps and Pyrenees implies ... Germany, and Britain was ... that which they now enjoy on ... or in the northern Asiatic ... latitudes of America. But ... opposed to that which ... of the southern group of animals.[2]

[1] ... Palæont. Soc. 1872, p. 27, *et seq.*

[2] This is treated at greater length in my "Essay on Classification," Quart. Geol. Journ. Nov. 1872, and in the "Introduction to British Pleistocene Mammalia," Palæont. Soc.

And the remains of the two groups of animals are so associated together in the caves, and river-deposits of Europe, north of the Pyrenees, that it is impossible to deny the fact that it was the common feeding-ground of both during the same era.[1]

Probable Cause of Association of Northern and Southern Groups.

Must we then infer that in the pleistocene age the present habits of the musk-sheep, the reindeer, chamois, or ibex, were so changed as to allow them to flourish side by side with the hippopotamus, or *vice versâ*? Was the climate colder than it is now in Europe, or was it hotter? How was this singular association of northern and southern species brought about? The problem may be solved if we refer to the present distribution of animals in northern Asia and North America. As the winter comes on the arctic species gradually retreat southwards, and occupy the summer feeding-grounds of the elk, red-deer, and other creatures which are unable to endure the extreme severity of an arctic winter. In the spring the latter pass northwards, to enjoy the summer herbage of that area, which had been the winter-quarters of the arctic group of animals. Thus there

[1] Mr. James Geikie's view ("The Great Ice-Age," 8vo. 1874) that the mixture of the northern and southern forms is due to the destruction of ossiferous strata by streams, which subsequently deposited remains of widely different ages together, is rendered untenable by the fact that they are generally preserved in the same mineral state. It would have been impossible for this to have taken place without leaving decided traces behind in the rolled and water-worn condition of the older series, such as may be seen in the case of the eocene and meiocene fossils in the Red Crag of Suffolk.

as a pendulum swinging to and fro, over the same region, of the northern and the temperate animals, and their remains must necessarily become more or less associated in the river-deposits, as well as in caves, where these last happen to occur. In northern Asia and in America, the only boundary between the northern and temperate zoological provinces is that constituted by the fluctuating annual temperature, and there are no great hilly barriers running east and west, to prevent free migration to the north or south. If reference be made to the map, Fig. 12[illegible], it will be seen that these conditions were amply satisfied in the pleistocene age. There were no physical barriers to migration, from the shores of the Mediterranean, as far north as Ireland. If the winter cold were severe, the reindeer and musk-sheep might advance as far south as the Pyrenees, and if the summer heat were intense there would be nothing to forbid the hippopotamus and the African carnivores advancing northwards. It seems to me that this is the only hypothesis which will satisfy all the facts of the case. The traces of glaciers and snow-fields where they are no longer found prove that the winter was severe; while the warmth of the summer seems to be sufficiently demonstrated by the presence of African species. Such extremes of temperature are presented, more or less, by all continents extending from high to low latitudes. They are modified in Europe at the present time by the warm current of the Gulf Stream, by the large area now occupied by the Mediterranean Sea, and by the submergence of the pleistocene lowlands on the Atlantic border.

The Temperate Group.

The third group of pleistocene mammalia consists of those still living in the temperate zones of Europe, Asia, and America:

Beaver.	Wolf.
Hare.	Fox.
Rabbit.	Horse.
Wild Cat.	Urus.
Martin.	Bison.
Stoat.	*Antelope saiga.*
Weasel.	Wild Boar.
Otter.	Stag.
Brown Bear.	Roe.
Grizzly Bear.	

The range of many of these animals has been profoundly modified since the pleistocene age. The *Antelope saiga* of the Don and Volga lived as far to the west as Aquitaine. The grizzly bear, instead of being restricted to its American habitat in the Rocky Mountains, ranged over the whole of Siberia into Europe, as far to the south as the Mediterranean, and westwards as far as Gibraltar.

The urus[1] still lives in the larger domestic cattle, and the bison is represented in Europe by those which are protected by the forest laws of Lithuania, and in North America by the vast herds which are rapidly being exterminated, like the red Indian, by the rifles of the settlers. The horse was as abundant, and as widely spread over Europe, as the urus and the bison; according to Prof. Brandt it now no longer lives in Siberia in a wild state.

[1] "Quart. Geol. Journ." xxii. 391.

[illegible]

[illegible]

[illegible] *R.* [illegible] *R.* [illegible] curved tusks [illegible] south of the Alps [illegible] northward as far [illegible] Yorkshire. The pigmy elephant and [illegible] are peculiar to the south, and the *Machairodus latidens*, or large sabre-toothed felis, [illegible] from the pleiocene age, of a peculiarly southern type.

The woolly rhinoceros, on the other hand, may be viewed as a northern form, since it is met with in vast abundance in the arctic regions of Siberia, as well as in Europe, and has not been found south of the Alps and

Pyrenees. The cave-bear has not been discovered either in the extreme north or in the south of Europe, and may therefore be considered of temperate range; and the Irish elk, identified by Prof. Brandt, from the caves of the Altai Mountains, had a similar range in middle Europe. The mammoth, endowed with an elastic constitution, was able to endure the severity of an arctic climate in Siberia and North America, and the temperature of the latitude of Rome and the Gulf of Mexico,[1] and consequently tells us as little of the pleistocene climate as the panther, fox, or wolf.

The evidence, therefore, as to climate, offered by the extinct animals in the caves is of the same nature as that of the living. There is the same mixture of northern and southern forms, which can only be accounted for satisfactorily by seasonal migrations, according to the summer heat and winter cold, such as those which are now observed to take place in Siberia and North America.

Before we consider the relation of the pleistocene animals buried in the caves and river deposits to the glacial period, it is necessary to define what is meant by the term glacial.

Two Periods of Glaciation in Britain.

At the close of the pleistocene period the climate gradually became colder, until ultimately it was arctic in severity in northern Europe. The researches of many eminent observers prove that an enormous sheet of ice, like that under which Greenland now lies buried, extended over North Britain, Wales, and Ireland, leaving

[1] See Falconer, "Palæont. Mem."

its mark in the far-travelled blocks of stone, the moraines, and the grooves which pass over the surface irrespective of the minor contours. The land then, most probably, as Prof. Ramsay and Sir Charles Lyell believe, stood higher than it does now. To this succeeded a period of depression, during which the mountains of Wales were submerged to a height of at least 1,300 feet ; and the waves of the sea washed out of the pre-existing glacial detritus the shingle and sand, termed the "middle drift," which occurs also in Scotland and Ireland.[1] Then the land was re-elevated above the waves, and a second period of glaciers set in, traces of which occur abundantly in Wales, Scotland, and Ireland, in the white areas in Fig. 126. They were, however, of far less extent than those which preceded them, occupying isolated areas instead of forming one continuous icy covering to the country. The glacial phenomena may be briefly summed up as follows: 1. As the pleiocene temperature was lowered, the glaciers crept down from the tops of the mountains, until at last they united to form one continuous ice sheet, moving resistlessly over the smaller hills and valleys to the lower grounds, and the first ice or glacial period set in. 2. Then followed the era of depression beneath the sea. 3. And, lastly, on the land re-emerging from the sea the second ice or glacial period began. The climate during the marine depression must obviously have been milder than that of either of the glacial periods, because of the moderating effect of the wide extent of sea.

[1] I have to acknowledge the kind assistance of Professors Hull and Harkness, Mr. Kinahan, and the Rev. H. M. Close, in correlating the Irish with the English glacial deposits. The reader will find the glacial period most ably treated in Lyell's "Antiquity of Man."

The exact relation of the boulder clays with marine shells, in the centre and south of Britain, to the detritus left behind by the ice-sheet in the north, has not as yet been satisfactorily ascertained. It is very probable that the elevation of land in the north was simultaneous with a southern depression, which allowed of icebergs depositing their burdens in the eastern counties, in the valley of the Thames, and as far south as Selsea, on the coast of Sussex.

Three Climatal Changes represented on the Continent.

These changes of climate have also been observed on the continent of Europe. The Swiss geologists have shown that the Alpine glaciers extended farther than they do at the present time, and that they present two stages of extension, the first of which is of greater magnitude than the second. The Alpine blocks and moraines have been traced far down into the plains of Lombardy, northwards into the valley of the Rhine, and in France as far south in the valley of the Rhone as Valence. The admirable essay and map brought by MM. Falsan and Chantre, before the meeting of the French Association for the Advancement of Science at Lyons, in 1873, show that there were two periods of glaciation in the valley of the Rhone, the one being due to the movement of an ice-sheet irrespective of the lower hills, the other being merely the work of the glaciers localized in the valleys. These in all probability correspond in point of time with the like stages of the complicated glacial phenomena in Britain. At this time the glaciers of the Pyrenees, now so small, extended at least from thirty to forty miles from their present posi-

Species.	Gallenreuth Cave.	Kirkdale.	Victoria.	Cefn.	Plas-newydd.	Plas Heaton.	Gailfaenan.	Paviland.	Bacon's Hole.	Minchin Hole.	Bosco's Den.	Crow Hole.	Ravenscliff.	Spritsail Tor.	Long Hole.	Blackrock Fissure.	Caldy Fissure.	Coygan Cave.	Hoyle Cave.	King Arthur's Cave.
Homo palæolithicus—Palæolithic Man	×		×		×										×				×	×
Spermophilus citillus—Pouched Marmot																				
Arctomys marmotta—Common Marmot																				
Castor fiber—Beaver																				
Lepus timidus—Hare		×												×	×					
Lepus variabilis Alpine Hare																				
Lepus cuniculus—Rabbit	×	×													×					
Lepus diluvianus—Extinct Hare																				
Lagomys pusillus—Tail-less Hare																				
Mus lemmus—Lemming																				
Hystrix dorsata—Porcupine	×																			
Felis leo (*var. spelæa*)—Lion		×		×									×	×	×					×
Felis pardus—Leopard																				
Felis Lynx—Lynx																				
Felis caffer—Caffir Cat																				
Felis catus—Wild Cat	×												×		×					
Machairodus latidens																				
Gulo borealis—Glutton	×					×														
Hyæna crocuta (*var. spelæa*)—Spotted Hyæna	×	×	×	×		×	×	×	×	×		×	×	×	×	×	×	×	×	×
Hyæna striata—Striped Hyæna																				
Mustela martes—Marten													×	×	×					
Mustela putorius—Pole-cat									×					×	×					
Mustela erminea—Weasel		×							×											
Lutra vulgaris—Otter															×					
Ursus arctos—Brown Bear	×	×	×					?						×					×	
Ursus ferox—Grizzly Bear	×	×	×	×	×				×	×				×						
Ursus spelæus—Cave-Bear	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×				×
Canis lupus—Wolf	×	×	×	×	×	×		×	×	×	×	×	×	×	×	×				
Canis vulpes—Fox	×	×	×	×	×	×		×	×	×	×	×	×	×	×					
Canis lagopus—Arctic Fox																				
Elephas primigenius—Mammoth	×		×					×					×	×	×	×	×	×		×
Elephas antiquus		×		×	×				×	×		×	×	×	×					
Elephas Africanus—African Elephant																				
Equus caballus—Horse	×	×	×	×		×		×					×	×	×		×	×		×
Rhinoceros tichorhinus—Woolly Rhinoceros	×		×	×										×	×	×	×	×		
Rhinoceros hemitœchus		×		×	×				×	×		×	×		×					
Rhinoceros megarhinus																				
Bos urus—Urus																				
Bos bison—Bison	×	×	×	×	×	×		×	×	×	×	×	×	×	×		×	×		×
Ovibos moschatus Musk Sheep																				
Capra ibex—Ibex																				
Capella rupicapra—Chamois																				
Antilope saiga—Saiga																				
Sus scrofa—Wild Boar	×	×		×				×	×	×	×	×	×	×	×					
Cervus elaphus—Stag	×	×	×	×	×				×					×	×					×
Cervus capreolus—Roe	×								×		×			×						
Cervus megaceros—Irish Elk	×	×	×	×	×									×	×					×
Cervus tarandus—Reindeer	×	×	×	×	×	×	×	×	×	×	×			×	×	×	×	×		×
Hippopotamus amphibius (*var. major*)—Hippopotamus		×		×	×								×							

Species.	Durdham.	Hutton.	Banwell.	Bleadon.	Uphill.	Sandford Hill.	Wookey Hole.	Brixham.	Kent's Hole.	Moustier.	La Madelaine.	Laugerie Haute.	Laugerie Basse.	Gorge d'Enfer.	Cro Magnon.	Les Eyzies.	Lunel Viel.	Belgian Caves.	River Deposits, Britain.	River Deposits, France.
Homo palæolithicus—Palæolithic Man .							×	×	×	×	×	×	×	×	×	×		×	×	×
Spermophilus citillus—Pouched Marmot .						×	×								×	×		×	×	
Arctomys marmotta—Common Marmot .																		×		
Castor fiber—Beaver . .									×								×	×	×	×
Lepus timidus—Hare .							×	×	×	×	×	×?	×?		×	×		×	×	×
Lepus variabilis—Alpine Hare . . .																		×		
Lepus cuniculus—Rabbit								×	×		×				×					×
Lepus diluvianus—Extinct Hare . . .							×										×	×		×
Lagomys pusillus—Tailless Hare . . .				×				×	×									×		
Mus lemmus—Lemming				×			×									×		×	×	
Hystrix dorsata—Porcupine																		×		
Felis leo (*var. spelæa*)—Lion	×	×	×	×	×	×	×	×	×					×	×	×	×	×	×	×
Felis pardus—Leopard .		×	×	×													×			×
Felis lynx—Lynx . . .			×															×		×
Felis caffer—Caffir Cat .																	×	×		
Felis catus—Wild Cat .				×	?				×								×	×	×	×
Machairodus latidens .									×											
Gulo borealis—Glutton .			×	×														×		
Hyæna crocuta (*var. spelæa*)—Spotted Hyæna	×	×	×	×	×	×	×	×	×	×							×	×	×	×
Hyæna striata—Striped Hyæna																	×			
Mustela martes—Marten				×																×
Mustela putorius—Polecat																		×		
Mustela erminea—Weasel									×									×	×	
Lutra vulgaris—Otter .	×			×					×									×	×	
Ursus arctos—Brown Bear	×			×		×	×	×	×									×	×	×
Ursus ferox—Grizzly Bear			×				×	×	×									×	×	×
Ursus spelæus—Cave-Bear		×	×	×		×	×	×	×				×	×	×		×	×		(?)
Canis lupus—Wolf . .		×		×	×	×	×	×	×		×	×	×	×	×	×	×	×	×	×
Canis vulpes—Fox . .		×		×	×	×	×	×	×		×	×	×	×	×	×	×	×	×	×
Canis lagopus—Arctic Fox																		×		
Elephas primigenius—Mammoth . . .	×	×	×	×		×	×	×	×	×	×	×	×		×	×		×	×	×
Elephas antiquus . . .	×			×														×	×	×
Elephas Africanus—African Elephant .																				
Equus caballus—Horse .	×	×	×	×	×	×	×	×	×	×	×	×	×		×	×	×	×	×	×
Rhinoceros tichorhinus—Woolly Rhinoceros			×			×	×	×	×									×	×	×
Rhinoceros hemitœchus .	×						×										×		×	
Rhinoceros megarhinus .																			×	×
Bos urus—Urus . . .			×	×		×	×	×	×								×	×	×	×
Bos bison—Bison . . .		×	×	×	×	×	×		?	×	×	×	×	×	×	×		×	×	×
Ovibos moschatus—Musk Sheep											×			×					×	×
Capra Ibex—Ibex. . .											×	×	×	×	×	×		×		×
Capella rupicapra—Chamois											×		×			×		×		×
Antilope saiga—Saiga .													×			×		×		
Sus scrofa—Wild Boar .		×		×	×		×		×		×				×		×	×	×	×
Cervus elaphus—Stag .			×	×			×	×	×	×	×	×	×		×	×	×	×	×	×
Cervus capreolus—Roe .				×				×										×	×	×
Cervus megaceros—Irish Elk		×	×	×			×		×			×						×	×	×
Cervus tarandus—Reindeer	×	×	×	×	×		×	×	×	×	×	+	×	+	×	×		×	×	×
Hippopotamus amphibius (*var. major*)—Hippopotamus . .	×								(?)										×	×

Cave Fauna the same as River-bed Fauna.

If this list[1] of animals from the caves be compared with that of the river-deposits of Britain and the continent, it will be seen that the same fauna is present in both, and that they are therefore of the same geological age.[2] This was the conclusion to which Dr. Falconer was led by the examination of the caves of Gower, and it has been confirmed by every subsequent discovery.

The Pleistocene Coast-line of North-Western Europe.

The identity of the British pleistocene fauna with that of the continent, leads to the conclusion that in the pleistocene age Britain was connected with the adjacent countries by a bridge of land, over which the wild animals had free means of migration. And this might be brought about by a comparatively small elevation of the area. The soundings show that Britain and Ireland constitute merely the uplands of a plateau now submerged to the extent of about 100 fathoms, on the side of the Atlantic. On the east it extends at a depth of from twenty to fifty fathoms, in the direction of Belgium; and on the south it is only sunk from twenty to forty fathoms below the sea-level. Immediately to the westward of this line the sea deepens so suddenly, that there is scarcely any difference between the lines of 100 and of 200

[1] The authorities for the foreign lists of animals will be found in the "Quart. Geol. Journ." 1872, p. 424. The British animals have been determined principally by myself and Dr. Falconer.

[2] "Classification of the Pleistocene Strata," Quart. Geol. Journ. Nov. 1872, p. 410.

fathoms, and the depth rapidly increases to 2,000. Were

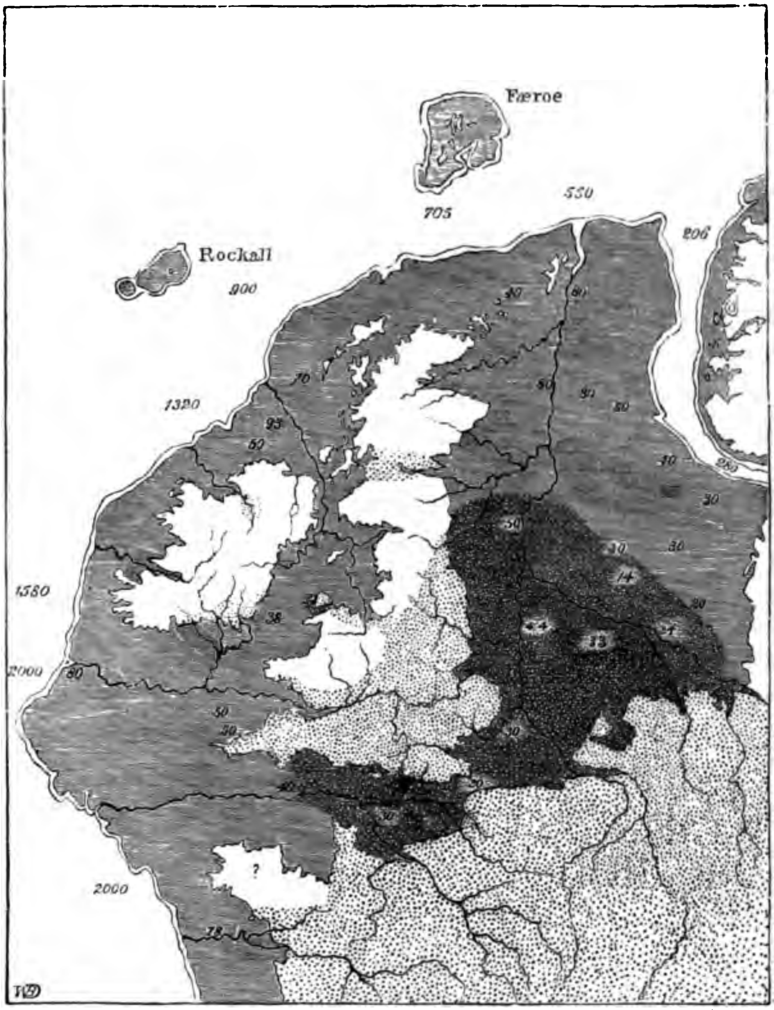


Fig. 126.—Physiography of Great Britain in Late Pleistocene Age.
Shaded area = land now submerged; dotted area = region occupied by animals; plain area = region occupied by glaciers.

this plateau elevated above the sea to an extent of 100

fathoms, the tract shaded in the map (Fig. 126) would unite the British Isles to the continent, and the Thames and other rivers on the eastern coast would unite with the Elbe and the Rhine to form a river debouching on the North Sea, somewhat after the manner which I have represented by taking the deepest line of soundings. The Straits of Dover would then be the watershed between this valley of the German Ocean, as it may be termed, and that of the English Channel, in which the Seine and the Somme and other French rivers joined those of the south coast, and ultimately reached the Atlantic. Evidence that the latter river flowed in the course assigned to it in the map is afforded by the discovery of the fresh-water mussel (*Unio pictorum*), recorded by Mr. Godwin Austen[1] to have been dredged up by Captain White from a depth of from 50 to 100 fathoms, not very far from what I have taken to be its mouth. We are also indebted to Mr. Godwin Austen for the discovery near this spot of banks of shingle and littoral shells, which indicate the position of the ancient coast-line.

The view that the 100-fathom line marks the limit of the pleistocene land surface to the west, is held by Sir H. de la Bêche, Mr. Godwin Austen, Sir Charles Lyell, and other eminent geologists, and it is supported by many facts that can be explained in no other manner. To pass over the discovery of a fresh-water shell at the bottom of the English Channel, quoted above, the distribution of fossil mammalia at the bottom of the German Ocean (represented in Fig. 126 by the dotted area) is

[1] Godwin Austen, "Quart. Geol. Journ." vol. i. p. 69. De la Bêche, "Theoretical Researches," p. 190. Lyell, "Antiquity of Man," 4th edit. p. 328.

analogous to that which we find in the river gravels and brick-earths on the land. The quantity of teeth and bones belonging to the mammoth, woolly rhinoceros, horse, reindeer, and spotted hyæna, and other animals, dredged up by the fishermen in the German Ocean is almost incredible. Mr. Owles, of Yarmouth, informed me in 1868 that off that place there is a bank on which the fishing nets are rarely cast without bringing up fossil remains. It seems most probable, that these accumulations have been formed under subaerial conditions near the drinking places, or below the fords, which were used for ages by the pleistocene animals. I might quote as an example of a similar deposit of fossils on the land, that discovered in 1866 by Captain Luard, R.E., in digging the foundations of the new cavalry barracks at Windsor, which consisted mainly of bones and antlers of reindeer, with a few carnivores, such as the brown bear and wolf, that usually follow reindeer in their migrations in Siberia.[1] Were this submerged it would be a case precisely similar to that off Yarmouth.

The ancient forest, exposed at low water under the cliffs on the Norfolk and Suffolk shores, flourished when the land stood higher than it does now. Traces of a similar forest, also at, and below, low-water mark, have been met with on the shore at Selsea, near Chichester, in Sussex; and remains of the mammoth have been dredged up in several places off the coast, as for example in Torbay and in Holyhead harbour, or found in gravel beds near low-water mark, as in the Isle of Wight, and on the north coast of Somerset at St. Audries, near Watchet, where a skull with gigantic tusks rested in the

[1] The accumulation of the remains of reindeer in the limited area of the excavation was enormous.

gravel. In all these facts we have ample proof that Britain stood at a higher level in the pleistocene age than at the present day.

The vast abundance also of the mammalia in the caves of South Wales and Somerset, and their presence in the Island of Caldy, and it may be added in Ireland, can only be accounted for by the elevation of the present sea-bottom, so as to allow of their migration over plains covered with abundant pasture. It seems, therefore, to me that the accompanying map, Fig. 126, represents with tolerable accuracy the ancient coast-line of Britain, and of the adjacent parts of the continent in the pleistocene age. The fertile valleys of the English Channel, Bristol Channel, and the German Ocean, would afford sustenance to a large and varied fauna, and numerous herbivores, such as the reindeer, bison, and horse, would supply food to the palæolithic hunters, who followed them in their annual migrations. And it must be remarked on this hypothesis, that the valley of the Garonne would offer a free passage both to the animals and to the hunters of Auvergne down to the prairie, extending as far as the 100-fathom line off the French coast, and that the hunting grounds would reach to Devonshire and Somerset without any barrier except that offered by the rivers. It is therefore no wonder that the implements in the caves of Kent's Hole, Wookey Hole, and the South of France, should be of the same type.

Distribution of Palæolithic Implements in this Area.

This geographical configuration in pleistocene times may perhaps account for the distribution of the palæolithic implements in the river gravels. The Seine and

the Somme debouch into the same valley as the rivers of the south of England, and the Straits of Dover mark the position of a low watershed leading into the valley of the German Ocean, on the sides of which, in the eastern counties, river-bed implements are so numerous. These are of the same type in northern France, Sussex, Hampshire, Kent, and as far north as the Wash; and were therefore used by the same race of men. The difference between them and those of the cave-dwellers in the south and west, may be due to their possessors occupying different hunting grounds. Each tribe of American Indians at the present time has its own territory for hunting, which is jealously guarded against encroachment, and in which the articles peculiar to the tribe are being accumulated in the refuse-heaps, while other sets are being accumulated in other districts. If we suppose that the palæolithic savages divided up their hunting grounds in this manner, the difference which exists between the implements of the river-beds and caves may be readily explained, as well as their being found for the most part in different areas.

The pleistocene climate in the area north of the Alps and Pyrenees will be treated in the eleventh chapter, after the examination of the cave-fauna of southern Europe.

CHAPTER X.

THE FAUNA OF THE CAVES OF SOUTHERN EUROPE AND THE EVIDENCE AS TO THE MEDITERRANEAN COAST-LINE IN THE PLEISTOCENE AGE.

Changes of Level in the Mediterranean area in Meiocene and Pleiocene Ages.—Bone-caves of Southern Europe.—Of Gibraltar.—Of Provence and Mentone.—Of Sicily.—Of Malta.—Range of Pigmy Hippopotamus.—Fossil Mammalia in Algeria.—Living Species common to Europe and Africa.—Evidence of Soundings.—The Glaciers of Lebanon.—Of Anatolia.—Of Atlas.—Glaciers probably produced by elevation above the Sea.—Mediterranean Coast-line comparatively modern.

In the preceding chapter we have seen that north-western Europe was elevated, during the pleistocene age, to an extent of at least 600 feet above its present level; so that Ireland was united to Britain, and Britain was joined to the mainland of Europe, proof of this elevation being dependent upon the soundings on one hand, and the distribution of the fossil mammalia on the other. Such a change must necessarily have affected the whole physical conditions of the area, since the substitution of a mass of land for a stretch of sea, and the higher altitude of the land, would tend to produce climatal extremes of considerable severity. It is indeed no wonder that during this time of continental elevation, the hills of

Wales, Yorkshire, Derbyshire, Cumbria, and Scotland should be crowned with glaciers, or that there should have been a migration to and fro of animals, comparable to that which is now going on in Siberia and the northern portions of North America. The condition of southern Europe at that time has a most important bearing on any conclusion which may be drawn as to the pleistocene climate in France, Germany, or Britain. For if it be proved that the Mediterranean Sea was then smaller than it is now, the greater land-surface would increase both the heat of the summer and the cold of the winter in central and north-western Europe.

Changes of Level in Mediterranean area in Meiocene and Pleiocene Ages.

The geological evidence that the Mediterranean region has been subjected to oscillations of level during the tertiary period, is clear and decisive. Prof. Gaudry[1] has proved, in his work on the fossil remains found at Pikermi, that the plains of Marathon, now so restricted, must have extended in the meiocene age far south into the Mediterranean, so as to afford pasture to the enormous troops of hipparions and herds of antelopes, the mastodons and large edentata, revealed by his enterprise. The rocky area of Attica, as now constituted, could not have supported such a large and varied group of animals, nor could the broken hills and limestone plateaux have been inhabited by hipparions and antelopes, if their habits at all resembled those of their descendants living at the present time. It may, therefore, reasonably be concluded

[1] "Les Oss. Foss. de Pikermi," 4to.

that Greece, in those times, was prolonged southwards, and united to the islands of the Archipelago by a stretch of land. If Africa were then as now the head-quarters of the antelopes, it is very probable that one of the lines by which they passed over into Europe, and spread over France and Germany, was in this direction. Nevertheless, it must be admitted that the changes of level, which have taken place since the meiocene age in those regions, are so complicated as to render it almost impossible to restore the meiocene geography.

In the succeeding, or the pleiocene age, the presence of the African hippopotamus in Italy, France, and Germany, can only be accounted for by a more direct connection with the African mainland than is offered by a route through Asia Minor. It would seem, therefore, that the Mediterranean Sea could not then have formed the same barrier to the northern migration of the animals which it does now. In many regions, however, the present land was then sunk beneath the sea, and marine strata, of pleiocene age, were accumulated in the Val d'Arno, Sicily, and southern France.

The physical geography[1] of the Mediterranean in the pleistocene age may be ascertained with considerable accuracy by the distribution of the animals, coupled with the evidence of the soundings.

Bone-caves of Southern Europe.

The mammalia in the bone-caves of southern Europe differ from those of the region north of the Alps and Pyrenees in the absence of the arctic species, and the

[1] Some parts of the rest of this chapter have been published in the "Popular Science Review," March 1873.

presence of some which are of a more strictly southern type. Nevertheless, the influence of the mountains in lowering the temperature in their neighbourhood is to be traced in the presence of the remains of certain animals. Thus, in the caves of Gibraltar we find an ibex, which cannot be distinguished from those of the Spanish sierras, and in Mentone and Provence, a marmot, specifically identical with that of the Alps.

The bone-caves in the neighbourhood of the Mediterranean afford most important testimony as to the geographical changes which have taken place, since the animals found in them lived in that region. We will take those of the Iberian peninsula first.

Caves of Gibraltar.

Ossiferous caverns have long been known to occur in the fortified rock of Gibraltar,[1] but were not examined scientifically until the year 1863, when the researches of Captain Brome, Prof. Busk, and Dr. Falconer, proved that pleistocene species were buried in considerable numbers in its cavities and fissures. Of these the most important is the great perpendicular fissure in Windmill Hill, called the Genista cave, which has been traced down to more than a depth of 200 feet. From the upper portion were obtained the polished stone implements, human skulls, and other neolithic remains described in the sixth chapter, p. 204, which prove that Gibraltar was inhabited by the Basques in the neolithic age, while the remains from the lower revealed the presence of a singularly mixed group of animals.

[1] "Palæontographical Memoirs," vol. ii. p. 554. Busk, Prehistoric Congress, Norwich volume, 1869.

The fossil bones have been referred by Prof. Busk and Dr. Falconer to the following species:—

Lepus cuniculus, rabbit.	*Equus caballus*, horse.
Felis leo, lion.	*Rhinoceros hemitœchus.*
F. pardus, panther.	*Capra ibex*, ibex.
F. caffer.	*Sus scrofa*, wild-boar.
F. pardina, lynx.	*Cervus elaphus*, red deer.
F. serval, serval.	*C. capreolus*, roe.
Ursus ferox, grizzly bear.	*C. dama*, fallow deer.
Canis lupus, wolf.	

The spotted hyæna, the serval, and *Felis caffer*, are species now peculiar to Africa, and it is obvious that they could not have found their way into Gibraltar under the present physical conditions of the Mediterranean. Elephants and rhinoceroses could not have lived on so barren and treeless a rock, unless it had overlooked a fertile plain, nor would the carnivora have chosen it for their dens, had it then been cut off from the feeding-grounds of the herbivores. Their presence, therefore, as Dr. Falconer justly remarks, implies the existence of land now sunk beneath the waves, but then extending southwards to join Africa.

To the African animals, mentioned above as inhabiting the Iberian peninsula in the pleistocene age, M. Lartet has added the African elephant (*E. Africanus*) and the striped hyæna (*H. striata*), which have been found in a stratum of gravel near Madrid along with flint implements.[1] None of the purely arctic mammalia, such as the reindeer, musk sheep, or woolly rhinoceros, so abundant in France, Germany, and Britain, have been met with south of the Pyrenees.

[1] "Comptes Rendus," xlvi. 1858.

Bone-caves of Provence and Mentone.

The arctic animals are also absent from the numerous bone-caves and bone breccias of Provence and Mentone. The pleistocene fauna of Provence consists, according to M. Marion,[1] of the spotted hyæna, and lion, *Elephas antiquus* or straight-tusked elephant, *Rhinoceros hemitœchus*, wild-boar, urus, stag, horse, and rabbit. The breccias in the island of Ratonneau have also furnished the porcupine, brown bear, and tailless hare. Man is proved to have been living in the district at the time by the discovery of perforated and cut bones, in the cave of Rians.

The fissures and caves of Mentone, explored by Mr. Moggridge[2] in 1871, and subsequently by M. Rivière, contained a fauna composed, according to Prof. Busk, of the following species:—

Marmot.	Brown bear.
Field-vole.	Cave-bear.
Lion.	Roe.
Panther.	Stag.
Lynx.	Ibex.
Wild-cat.	Urus.
Spotted hyæna.	Horse.
Wolf.	Wild-boar.
Fox.	*Rhinoceros hemitœchus.*

Along with these were large quantities of charcoal and flint flakes, which proved that man had inhabited the district while the deposits were being formed.

[1] Prehistoric Congress, Paris volume, p. 96.
[2] "Brit. Ass. Reports," Edinburgh, 1871.

Mr. Moggridge gives the following account of the results of his exploration:—[1]

"The caves of the red rocks, half a mile out of Mentone, are in lofty rocks of jurassic limestone on the shore of the Mediterranean, and at an average height of 100 feet above that sea, the rocks themselves attaining an elevation of 260 feet. They have now been repeatedly rifled by the learned or the curious; but when the principal cave (Cavillon) was nearly intact, the author made a section of it from the modern or highest floor, down to the solid rock. There were five floors formed in the earth by long-continued trampling; on each, and near the centre, were marks of fire, around which broken bones and flints were abundant, except upon the lowest, where but few bones occurred, and no flints. The bones were those of animals still existing. Few implements were found, but many chips of flint, some cores and stones used as hammers. Perhaps this cave was used as a place for manufacturing flints, which must have been carried from their native bed, distant about one mile.

"There is nothing to evince the action of water; on the contrary, the numerous stones that occur are all angular . . . . Below these caves a slope of about 180 feet descends to the edge of the sea. Through the upper part of this slope, at distances from the cave of from 0 to ten feet, is a railway cutting 600 feet long, fifty-four feet deep, and sixty feet above the sea. The mass removed in making this cutting was composed of angular stones not waterworn. Loose at the surface, it soon became a more or less mature breccia, for the most part so hard that it was blasted with gunpowder." In this breccia, and at various depths, some of more than thirty

[1] "Brit. Assoc. Rep." 1871.

feet, the author has taken out teeth of the bear (*Ursus spelæus*) and of the hyæna (*Hyæna spelæa*) while with and below those teeth he found flints worked by man.

The subsequent exploration by M. Rivière[1] has resulted in no important addition to the fauna: the famous human skeleton having been, as I have already remarked in the seventh chapter, interred in the pleistocene strata, and probably not palæolithic. It may possibly be of the era of the upper floors described by Mr. Moggridge, in which all the remains belong to living species.[2]

This cave-fauna is more closely related to that of southern Europe than to that north of the Alps and Pyrenees. The striped hyæna found in the cave of Lunel-viel, Hérault, by Marcel de Serres, along with the reindeer and other animals, probably belongs to the same southern group.

Bone-caves of Sicily.

Certain members of the African fauna are also proved to have ranged northwards over Europe in the direction of Sicily, by the discoveries in the caves of that island. The Sicilian bone-caves have been worked for the sake

[1] *Découverte d'une Squelette Humaine de l'époque Paléolithique dans les Cavernes de Baoussé-Roussé, dites Grottes de Menton*, 1873; also Prehistoric Congress, Brussels volume. M. Rivière adds the Wapiti, or large variety, and the *Cervus Corsicanus*, or small variety of the stag, the chamois, and the woolly rhinoceros (the two last of which may be perhaps identical with the ibex and *R. hemitœchus*, determined by Prof. Busk, as neither is mentioned by M. Rivière), and the *Capra primigenia* of Gervais, a large goat commonly found in neolithic caves.

[2] The depth at which the skeleton was found is a matter of dispute, the estimates varying from seven feet (Pengelly) to (6·55 m.) 21·49 feet (Rivière). Pengelly, *Cave man of Mentone*, "Trans. Devon Ass." 1873, pp. 10 and 13.

of the bones since the year 1829; and of these many shiploads were sent to Marseilles from San Ciro, belonging, according to M. de Christol, principally to the hippopotamus. In 1859,[1] Dr. Falconer examined the collections made from this cave, as well as those which remained *in situ*, and carried on further researches into a second in the neighbourhood, known as the Grotto di Maccagnone, and in the following year two others were discovered and explored in northern Sicily by Baron Anca. The species were as follows:—

Homo, man.
Felis leo, lion.
Hyæna crocuta, spotted hyæna.
Ursus ferox,[2] grizzly bear.
Canis.
Cervus, deer.
Bos, ox.
Equus, horse.
Sus scrofa, boar.
Elephas antiquus.
Elephas Africanus, African elephant.
Hippopotamus major, hippopotamus.
Hippopotamus Pentlandi.
Lepus.

The presence of man was indicated by charcoal and flint flakes.

The African elephant was obtained from three caves: from that of San Teodoro, by Baron Anca; from Grotta Santa, near Syracuse, by the Canon Alessi; and from a cave near Palermo, by M. Charles Gaudin. It is obvious that the presence of this animal, as well as of the spotted hyæna, in Sicily can only be accounted for on the hypothesis that a bridge of land formerly existed, by which they could pass from their head-quarters, that is to say Africa. On the other hand the presence of the grizzly bear, and of the *Elephas antiquus* implies that they

[1] "Palæont. Mem." ii. p. 543.
[2] It is of the same species as the bear from Grays Thurrock.

passed over into Sicily, from their European head-quarters, before the existence of the Straits of Messina, since both animals are abundant on the mainland of Europe. The larger species of hippopotamus, doubtfully referred by Dr. Falconer to the *H. major* (= *H. amphi-*

Fig. 127.—Molar of *Hippopotamus Pentlandi* (1/1). (Sicily.)

bius), may have crossed over either from Italy, where its remains are very abundant in the pleiocene and pleistocene strata, or from Africa.

A small species of hippopotamus, *H. Pentlandi*, Fig. 127, occurs in incredible abundance in the Sicilian caves. It bears the same relation, in point of size, to the fossil variety of the African hippopotamus, as the living *H. liberiensis* does to the latter.

Bone-caves of Malta.

The bone-caves of Malta were first scientifically explored by Admiral Spratt, in 1858, and subsequently by Dr. Leith Adams, and others. The Maghlak Cave near the town of Crendi, contained large quantities of the *Hippopotamus Pentlandi*, together with the gigantic dormouse, named *Myoxus Melitensis*. A short distance off a second cavern, explored by Dr. Leith Adams, contained numerous remains of at least two species of pigmy

elephant about the height of a small horse. Its small size may be gathered from the accompanying woodcut (Fig. 128) of the last lower true molar, taken from the litho-

FIG. 128.—Molar of *Elephas Melitensis*, Malta (⅓). (Falconer.)

graph published in Dr. Falconer's "Palæontographical Memoirs," vol. ii. pl. xii.

Range of Pigmy Hippopotamus.

The pigmy hippopotamus has lived also in other districts in the Mediterranean region. One of its teeth, now preserved in the British Museum, was discovered by Dr. Leith Adams, in Candia. In 1872 I identified in the Oxford Museum a last lower true molar, which extends the range of this species to the mainland of Europe. It was obtained by Dr. Rolleston from a Greek tomb at Megalopolis, in the Peloponese, and was probably derived from one of the many caves in the limestone of that district. For this extinct animal to have spread from Sicily to Malta, from Malta to Candia, and from Candia to the Peloponese, or vice versâ, these three islands must have been united to the Peloponese and have been the higher grounds of land, now submerged beneath the waves of the Mediterranean.

The view therefore, advanced by Dr. Falconer and Admiral Spratt, that Europe was connected with Africa

by a bridge of land, extending northwards from Sicily, is fully borne out by an examination of the fossil remains both of that island and of Malta (see Fig. 129).[1]

Fossil Mammalia in Algeria.

If the African mainland extended to Europe in the direction of the Straits of Gibraltar, and of Malta and Sicily, so as to afford passage for the African mammalia into Europe, it would equally afford passage for the southern advance into Africa of some of the European mammalia. Evidence of this we meet with in a stratum of clay at Mansourah, near Constantine, in Algeria, described by M. Bayle in 1854.[2] The animals which he obtained, consisting of the ox, antelope, hippopotamus, and elephant, have been described by Prof. Gervais. An examination of his figure of a fragment of a molar tooth leaves no room for doubt, that the *Elephas meridionalis* was living in north Africa during the pleistocene age; that is to say an extinct animal, the head-quarters of which are to be found in Italy, ranged as far south as northern Africa.

Living Species common to Europe and Africa.

The former continuity of Africa by way of the Iberian peninsula and Sicily, may also be inferred by the distribution of the mammalia at the present time. Prof. Gervais[3] observes that most of the insectivora are

[1] Falconer, "Palæont. Mem." vol. ii. p. 552. Spratt, "Quart. Geol. Journ." xxiii. p. 293.

[2] "Bull. Soc. Géol. Fr." 2e sér. t. xi. p. 340.

[3] Gervais, "Animaux Vertébrés Vivants et Fossiles," 4to. p. 88.

the same in Europe and north Africa. The genette and ferret (*Fœtorius furo*), the *Mangousta Widdringtoni* (Gray), and the fallow deer, are common to Spain and Africa. The porcupine of Algeria belongs to the same species as that of Italy and Sicily, and the wild boar does not present any characters of importance by which it can be separated from that of Europe. From the present range, therefore, of the mammalia the same conclusion may be drawn as to the continuity of Africa with Europe as is afforded by their distribution in the pleistocene age.

Evidence of Soundings.

These conclusions derived from the study of the mammalia, are corroborated and supplemented by the evidence of the soundings. As we enter the Straits of Gibraltar (Fig. 129) the Atlantic Ocean shallows, until between Tangiers and Tarifa it is not more than from 270 to 300 fathoms. Between Tarifa and Ceuta the sea measures from 300 to 400 fathoms, and thence, in passing eastwards, suddenly deepens to the extent of over 1,500 fathoms. An elevation of 400 fathoms would be quite sufficient to raise a barrier of land between Morocco and Spain, and to insulate the deep Mediterranean basin from the Atlantic. The soundings between Sicily and Tunis are 260 fathoms; between the former place and Malta, 55 fathoms; between Malta and the African mainland, 344 fathoms. An elevation of 400 fathoms would suffice therefore to connect Africa with Sicily, and to insulate the eastern from the western Mediterranean depths. To the east of Sicily the soundings reveal a depth of over 2,000 fathoms, and this deep

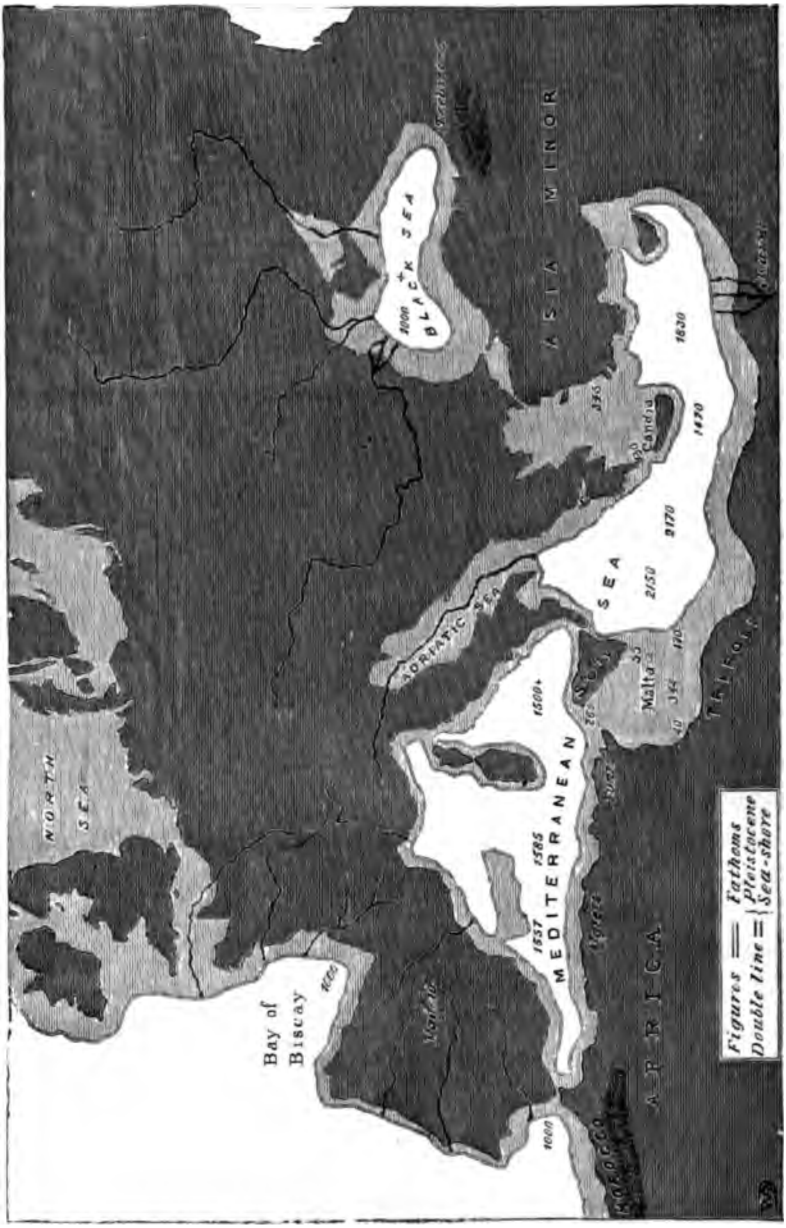


FIG. 129.—Physiography of Mediterranean in Pleistocene Age.

basin extends as far to the east as Cyprus and Asia Minor. Between Candia and the Peloponese, the sea is 460 fathoms deep. An elevation therefore from 400 to 500 fathoms would allow of the passage of *Hippopotamus Pentlandi* from Candia to the Peloponese, and thence by southern Italy into Sicily and Malta. I have therefore represented in the map what would be the necessary result of the elevation of the bottom of the Mediterranean to that extent. Two great barriers of land would unite Africa with Spain and Italy, and enable the African mammalia to find their way into the regions north of the Mediterranean Sea. The shallowness of the sea at those two points indicates the existence of the sunken barriers. The African elephant however did not pass far northwards, since it has only been met with in Spain and Sicily.

Such a change in level as this would convert the Adriatic into dry land, and cause the islands of the Grecian Archipelago to rise high above the surrounding plains. The 500-fathom line is therefore taken to represent the probable sea margin of the pleistocene age, although in centres of volcanic activity, such as Sicily and the Archipelago, local changes of level, even of greater magnitude, may have taken place.

This view of the former elevation of the Mediterranean area to a height of from two to three thousand feet above the present level will go far to explain the remarkable traces of glaciers discovered in Syria, Anatolia, and Morocco.

The Glaciers of Lebanon.

Dr. Hooker, in his journey to Syria in 1860, discovered that the cedars of Lebanon grew principally on one

spot, on old moraines which traverse the head of the Kedisha valley. This valley terminates in broad, shallow, open basins at a height of about 6,000 feet above the sea, resembling the corries of the Highlands; and one of these, in which the cedars grew, was divided into two distinct flats by a transverse range of ancient moraines from 80 to 100 feet high and with perfectly defined boundaries. "The rills from the surrounding heights collect in the upper flat, and form one stream, which winds among the moraines on its way down to the lower flat, whence it is precipitated into the gorge of the Kedisha. The cedars grow on that portion of the moraine which immediately borders this stream, and nowhere else; they form one group about 400 yards in diameter, with an outstanding tree or two not far from the rest, and appear as a black speck in the great area of the corry and its moraines, which contain no other arborious vegetation, nor any shrubs, but a few berberry and rose bushes that form no feature in the landscape." [1]

In ancient times, therefore, the glaciers descended to a height of about 6,000 feet above the sea, and were fed by the perennial snow-fields of the crest of Lebanon.

The Glaciers of Anatolia.

The former presence of glaciers at nearly the same altitude has also been proved by the travels of Mr. Gifford Palgrave in Anatolia,[2] especially in the valley through which the Chorok flows, and in the mountainous country to the north-east, between Georgia and the

[1] Hooker, "Nat. Hist. Review," II. p. 12, 1861.

[2] *Nature*, vol. v. p. 444; vol. vi. 536.

Black Sea. The river Chorok runs about 120 miles in a north-easterly direction, and is separated from the Euxine by a mountain chain reaching a height of 11,000 feet, thus forming a long strip of land, which is called Lazistan after its inhabitants, a tribe of Lazes. It then turns suddenly to the north, where it falls into the sea. The southern side is determined by mountains of Cretaceous, Jurassic, and Plutonic rocks, which form the watershed between the tributaries of the Black Sea and Persian Gulf. Three large moraines are to be found on the southern side of the valley, their lower extremity about 5,000, their upper origin nearly 8,000 feet above the sea. No moraines are seen where the chain does not reach an altitude of 7,000 feet, though angular boulders are not uncommon. The upper mountain contours are invariably rounded, and smoothed off, and the sides are scooped too widely for the depressions to have been caused by water. Low down in the valley the slopes terminate in rifted precipices.

That these moraines were posterior to the volcanic eruptions in the district, is evident from the examination of a broad stone ridge, near the highest point to the east of Erzeroum, where at a height of 7,000 feet the Jurassic limestone was interrupted by a volcanic outbreak of several miles in extent. Traces of a crater were visible. Above, the granite peaks rose to a height of 9,000 feet; below, a wide moraine crossed the road, composed of volcanic fragments mixed with granite. Consequently, it must have been formed after the volcano had become extinct. Similar traces are to be found at Keskeem Boughaz. Mr. Palgrave concludes "that the ice-cap of the north-eastern Anatolian watershed, in post-pleiocene (pleistocene) times, must have reached downwards, on

the northern side of the range, to 7,000 feet above the present sea-level, while some of the glaciers issuing from it descended to about 4,500 of the same measurement." Striated and ice-worn boulders, especially of granite, were very abundant. This region, it must be observed, is within sight of the lofty granite range of Tortoom, which is "streaked with perpetual snow."

After leaving the Chorok valley and getting on to the watershed, at a distance of fifty miles to the north-east, Mr. Palgrave reached the main ridge or backbone of the land. Here, among the limestone ledges, about 6,400 feet above the sea, is a colossal moraine, formed of worn granite blocks, partly overgrown with forest, and descending from a height of over 8,000 feet. It is divided, by a valley, from a lofty undulating granite plateau that is scooped out here and there into deep oval lakes, always full of blue water. The sides of the plateau are strewn with boulders of granite, brought from the higher peaks about five miles off. These boulders occur in greater or less abundance down to the basin of the Ardahan, near the sources of the Kur or Cyras, which joins the Araxes before flowing into the Caspian. The height of this Ardahan basin is about 6,500 feet; it is, but for a slight easterly slope, a water level. The bottom consists of deep alluvial soil mixed with detritus and boulders; the sides are rounded and smoothed, and bear every mark of long ice-covering. These plateaux, studded with lakes, stretch east to Russo-Georgia, till their greatest height is gained at Kel Dagh, a mountain about 11,000 feet high: thence they descend to the plains of Georgia and the Black Sea.

No glacial marks have been observed on the sea-ward side of the range, except at Hamshun in the Lazistan

mountains, between the River Riom and Trebizond. Here, at 6,900 feet, is a granite-strewn plateau, thinly green with grass, sheltered from the sea by lofty peaks on the north-west, and backed to the south-east by tremendous jagged granite cliffs, the highest 12,500 feet above the sea. "The plateau itself is about forty miles in length, irregular in breadth, its surface rounded and jotted over with boulders. But just as my track led near under the base of Verchembek, at an altitude of 8,300 feet, it crossed a large broad moraine," descending from the higher slopes, and having its base in a broad bare valley not far below, which showed that here, at the highest and widest part of the Lazistan chain, perpetual ice had once existed in sufficient quantity to furnish at least one glacier. From this case it seems that the limited ice-cap of the Hamshun highlands extended no further down than 8,500 or 9,000 feet, or from 1,000 to 2,000 feet lower than the glacial covering of the inland range.

The Glaciers of the Atlas Mountains.

Similar traces of glaciers have been observed in the Atlas mountains by Mr. George Maw,[1] in his travels in Morocco with Dr. Hooker and Mr. Ball in 1871. "After four hours' continued ascent," he writes (p. 19), "the termination of the glen comes into full view, and we observe with great interest that it is closed by a group of moraines, proving the former existence of glaciers in the Atlas, and confirming my opinion that the great boulder beds flanking the chain are also of

[1] "A Journey to Morocco, and the Ascent of the Great Atlas," 8vo. Slater, Tronbridge, Salop.

glacial origin. Two villages, probably the highest in the Atlas, are built on the principal moraine; Eitmasan, at ts base, at a height of 6,000 feet, and Arroond, near its ummit, at a height of 6,800 feet; the terminal angle of he larger moraine having a vertical height of 800 feet. t is composed of immense blocks of porphyry, lying .t a steep angle of repose, up which it takes us nearly .n hour to climb. The existence of these moraines in atitude $30\frac{1}{2}°$ N. (the latitude of Alexandria) is perhaps he most interesting fact we noticed during our journey, or this is the most southerly point at which the evidence f extinct glaciers has been observed, and tends to confirm the opinion entertained by many geologists, that he refrigeration during the glacial period was almost iniversal."

Glaciers probably the result of elevation above the Sea.

The elevation of the African moraines above the sea, f about 6,000 feet and upwards, is nearly the same as hose of Asia Minor. If the mountains of the Atlas, .azistan, and Lebanon shared in the upward movement f the Mediterranean area, the addition of 3,000 feet to he height could not fail to leave marks behind of the ow temperature thereby caused. It is very probable, hat during the time the Mediterranean was reduced to wo land-locked seas, these mountains were covered with now-fields, and constituted the ice-sheds of glaciers.

From the range of the mammalia we have inferred the xistence of land barriers, extending across from Africa o Spain and Italy, and from Candia to Greece, and their ctual existence beneath the sea has been proved by

soundings, which necessitate an elevation of from 400 to 500 fathoms to bring them above the sea-level. We have also seen that the higher mountains, which most probably participated in this upward movement, bear traces of a lower temperature in the moraines of the Atlas and Lazistan. The hypothesis of such an elevation during the pleistocene age may therefore be taken to be proved so far as it explains two widely different classes of facts, the distribution of the mammals and the existence of glaciers where they are now unknown.

The physical condition of the Mediterranean area, in the pleistocene age, may be summed up as follows. The mainland of Africa extended northwards to join Europe, in the direction of Gibraltar and Italy. The islands of Malta and Sicily were hilly plateaux, overlooking an undulatory plain. Corsica and Sardinia were joined to Italy, Majorca and Minorca to Spain, Candia to Peloponese, and Cyprus to Asia Minor. The area now occupied by the Adriatic Sea constituted the lower valley of the Po, and the Archipelago was a plain studded with volcanic cones; and at the same time glaciers crowned the higher mountains of northern Africa and of Asia Minor.

The substitution of land for a stretch of sea, in the Mediterranean, could not fail to cause the summer heat to be more intense in the region to the north than at the present time, while the increased elevation would produce a greater severity of winter cold, as Mr. Godwin Austen has pointed out in the case of the hills of Devonshire. When, indeed, we consider that the pleistocene land surface extended from the snowy heights of Atlas, as far north as the 100-fathom line off the coast of Ireland, we might expect to find African animals, such as the spotted hyæna and *Felis caffer*, ranging as

far north as Yorkshire, for the only barrier to their migration would be that offered by the severity of a pleistocene winter.

Mediterranean Coast-line comparatively modern.

The submergence of the barriers, and the constitution of the Mediterranean as we find it now, have probably taken place but a short time ago, from the geological point of view, though we know that for the last 3,000 years the coast-line has been on the whole unchanged, except from the silting out of the sea by the sediment of rivers, such as the Po, and the elevation and depression of small areas by volcanic energy, as at Santorin. The physical character of the shores testifies to the truth of this view.

"On entering the Straits of Gibraltar," Mr. Maw writes, "from the Atlantic, a notable change takes place in the aspect of the coast. Cape St. Vincent, on the Atlantic coast, presents a bold line of cliffs to the sea, and bluff cliffs extend many miles towards the Straits; but as soon as these are passed, a change of coast-form takes place, which must be noticeable to every observer. Cliffs on the sea-board become the exception, and the general line of the coast is merely a shelving under the sea of the general hill-and-valley system of the land, the sea running up all the depressions, and the land elevations spreading out into the sea with scarcely any abrupt cliff-line of demarcation. The uneven sea-bottom of the Straits seems to be a continuation of the contour of the adjacent land, consisting of rolling alternations of hill and valley, which must have received its conformation by subaerial agencies."

"Corsica, and the adjacent islands of Elba, Capraja, and Monte Christo, are also remarkable for the absence of cliffs, and are wanting in those abrupt escarpements separating land and water which are so abundant on our own coasts. Their aspect is that of mountain-tops rising out of the sea, suggesting to the eye the seaward prolongation of their subaerial contour of sloping hill-sides and river-cut valleys, as though the sea had not stood sufficiently long at its present level to excavate an escarpement. The deep intersecting bays that occur along the coast from Marseilles to the Riviera suggest the same conclusion, the undulating land surface spreading down to the water's edge, and the deep bays running up the intervening valleys, which must have had an origin common with that of their landward prolongations."

It is impossible to shut our eyes to the full force of this reasoning. The present aspect of the Mediterranean is, geologically speaking, a thing of yesterday.

Changes of Level in the Sahara coincident with those in the Mediterranean.

But if the Mediterranean area has been depressed to an amount of from 2,000 to 3,000 feet since the pleistocene age, we have proof that the region to the south has been elevated to that extent in comparatively modern times. Mr. Maw,[1] in his journey in 1873 to the Northern Sahara, observed raised beaches at a height of 2,000 feet, and loam and shingle-beds as high as 2,700 feet. He therefore concludes that the part of the Sahara which he explored had been raised at least 3,000 feet above the sea. These changes of level, the same in amount, but

[1] "Geological Notes on a Journey from Algiers to Morocco." Geol. Soc. Feb. 25, 1874.

in opposite directions, were probably compensatory and simultaneous. Northern Africa may have been cut off from the central and southern portions of the continent by the sea extending over the Sahara, during the time that the Mediterranean was represented by the two inland salt lakes figured in the accompanying map (Fig. 129). And while the region of the Sahara was being elevated, that of the Mediterranean was probably being depressed.

These changes in the relation of sea to land, and the greater elevation of the mountains in the neighbouring countries, must have affected not merely the climate of southern, but also of north-western Europe, and ought not to be left out of account in any theory relating to pleistocene climate.

CHAPTER XI.

THE EUROPEAN CLIMATE IN THE PLEISTOCENE AGE.

The evidence of the Mammalia as to Climate.—The Southern Group. —The Northern Group.—Probable cause of Association of Northern and Southern Groups.—The Temperate Group.—Species common to Cold and Tropical Climates.—Extinct Species.—Two Periods of Glaciation in Britain.—Three Climatal Changes represented on the Continent.—Europe invaded by Pleistocene Mammals before the Glacial Period.—Mammals lived in Britain during the Second Ice or Glacial Stage.—The Glacial Period does not separate one Life-era from another.—Relation of Palæolithic Man to Glacial Period.—Age of Contents of Caves in Glaciated Districts.

The Evidence of the Mammalia as to Climate.

IN the last three chapters we have seen that the cave-mammalia throw great light on the pleistocene geography of Europe, and that there is reason for the belief that the land surface then extended northwards and westwards, so as to include Ireland ; and southwards to join Africa, in the direction of Sicily, Malta, and Gibraltar. We must now pass on to the consideration of the climate on this great continental area, which would allow of so large and varied a fauna existing in our quarter of the world.

The Southern Group of Animals.

The pleistocene fauna is remarkable for the mixture of species. It consists of forms now banished to South Africa, Northern Asia, and America, or to the severe climate of high mountains, mingled with those which lived in Europe in the historic age, and those which have wholly disappeared from the face of the earth. We will take the living species first.

The southern group consists of the following animals:—

Lion.	Serval.
Caffir Cat.	Hippopotamus.
Spotted Hyæna.	African Elephant.
Striped Hyæna.	Porcupine.

At the present day the lion ranges over the whole of Africa, with the exception of Egypt and the Cape Colony, whence it has been driven out by the hand of man. In Asia, the maneless variety inhabits the valley of the Tigris and Euphrates, and the districts bordering on the Persian Gulf; and in India, according to Mr. Blyth, the province of Kattywar in Guzerat. Although now only found in these hot regions, it is proved, by the concurrent testimony of Herodotus, Aristotle, Xenophon, Ælian, and Pausanias, to have inhabited the mountains of Thrace, and of Asia Minor, and it probably became extinct in Europe before the end of the first century after Christ.[1] We may therefore infer that it possessed a sufficient elasticity of constitution to endure

[1] See "British Pleistocene Mammalia," Palæont. Soc. *Felis spelæa*, c. xviii.

a considerable degree of cold, although its present distribution implies that it is better fitted to thrive in a tropical than in a cold climate. The Caffir cat (*Felis caffer* of Desmarest) is an African species, which has been discovered by Mr. Ayshford Sanford and myself, in Somersetshire; it also occurs in the caves of Germany, France, and Gibraltar. The spotted hyæna now lives only in South Africa, while the striped species ranges through Africa and the warmer regions of Asia. It was extremely rare in Europe in the pleistocene age, and has not been identified in any deposit further north than Lunelviel, in southern France. The hippopotamus, now found only in middle and southern Africa, is proved by its fossil remains to have formerly dwelt in the region of the Lower Nile, as well as in Algeria. The serval and African elephant have been found in the Iberian peninsula, and the latter in Sicily.

The evidence afforded by the animals, as to the pleistocene climate of those portions of Europe which they inhabited, differs considerably in point of value, but on the whole indicates that it was temperate, or comparatively hot; for although the elasticity of constitution which we know to have been possessed by the lion, was probably shared by the spotted hyæna, it is very unlikely that so aquatic an animal as the hippopotamus could have ranged from southern Europe, as far north as Yorkshire, under any other than temperate conditions. It could not have endured a winter sufficiently severe to cover the rivers with a thick coating of ice, without having its present habits profoundly modified; and such an alteration of habits would certainly leave its mark, in other modifications in the fossil skeleton than those minute differences which have been observed, when

it is compared with that of the living *Hippopotamus amphibius*. The porcupine of southern Europe has been found as far north as the caves of Belgium (Schmerling).

The Northern Group.

The northern group consists of those animals which are now only to be met with in the colder regions of the northern hemisphere, either in low latitudes or at great altitudes.

Marmot.	Arctic Fox.
Pouched Marmot.	Musk-sheep.
Lemming.	Reindeer.
Alpine Hare.	Ibex.
Tailless Hare.	Chamois.
Glutton.	

To this list the palæolithic man of the caves must be added, since he is probably related by blood to the Eskimos, and appeared in Europe simultaneously with the arctic group of animals.

The testimony of these animals as to climate is directly opposed to that of the preceding group, since they now only flourish in the arctic regions, or in mountainous districts in which the climate is severe. The marmot, in the pleistocene age, lived in Belgium, and descended from the Alpine heights as far as the shores of the Mediterranean, where it has been met with in the caverns near Nice. The pouched marmot, *Spermophilus citillus* of the Don and Volga, penetrated as far to the west as Somersetshire. The Alpine hare, now found only in the colder climates of northern Europe, Asia, and America (with the solitary exception of Ireland), ranged as far down the valley of the Rhine as Schussenreid, in Suabia. The two carnivores now dwelling in the colder

regions of the north, the glutton or wolverine, and the arctic fox, have been discovered, the one as far south as France, the other as far as Schussenreid, and both probably occupied the whole of Germany, and of northern Russia, in the pleistocene age.

The musk-sheep,[1] the most arctic in its habit of all the herbivores, is, at the present time, restricted to the high latitudes of North America, where it thrives in the desolate, treeless, barren grounds, not even being driven from its haunts by the extreme severity of the winter. It has been traced, by its fossil remains, from its present abode, across Behring's Straits, and through the vast Siberian steppes, into Russia in Europe, Germany, Britain, and as far south and west as the barrier offered by the Pyrenees. Throughout this large area its remains occur in association with the reindeer, and both these animals, as I have remarked above, were hunted by the palæolithic dwellers in the caves of Aquitaine, just as they are now hunted by the Eskimos on the shores of the Arctic Ocean.

If the present habits of these animals be any index to their mode of life in the pleistocene age, their presence in the area north of the Alps and Pyrenees implies that the climate in France, Germany, and Britain was severe, or analogous to that which they now enjoy on the tops of lofty mountains, or in the northern Asiatic steppes, or the high northern latitudes of America. But this conclusion is diametrically opposed to that which is based on the evidence of the southern group of animals.[2]

[1] "*Ovibos moschatus*," Palæont. Soc. 1872, p. 27, *et seq.*

[2] This is treated at greater length in my "Essay on Classification," Quart. Geol. Journ. Nov. 1872, and in the "Introduction to British Pleistocene Mammalia," Palæont. Soc.

And the remains of the two groups of animals are so associated together in the caves, and river-deposits of Europe, north of the Pyrenees, that it is impossible to deny the fact that it was the common feeding-ground of both during the same era.[1]

Probable Cause of Association of Northern and Southern Groups.

Must we then infer that in the pleistocene age the present habits of the musk-sheep, the reindeer, chamois, or ibex, were so changed as to allow them to flourish side by side with the hippopotamus, or *vice versâ?* Was the climate colder than it is now in Europe, or was it hotter? How was this singular association of northern and southern species brought about? The problem may be solved if we refer to the present distribution of animals in northern Asia and North America. As the winter comes on the arctic species gradually retreat southwards, and occupy the summer feeding-grounds of the elk, red-deer, and other creatures which are unable to endure the extreme severity of an arctic winter. In the spring the latter pass northwards, to enjoy the summer herbage of that area, which had been the winter-quarters of the arctic group of animals. Thus there

[1] Mr. James Geikie's view ("The Great Ice-Age," 8vo. 1874) that the mixture of the northern and southern forms is due to the destruction of ossiferous strata by streams, which subsequently deposited remains of widely different ages together, is rendered untenable by the fact that they are generally preserved in the same mineral state. It would have been impossible for this to have taken place without leaving decided traces behind in the rolled and water-worn condition of the older series, such as may be seen in the case of the eocene and meiocene fossils in the Red Crag of Suffolk.

is a continued swinging to and fro, over the same region, of the arctic and the temperate animals, and their remains must necessarily become more or less associated in the river-deposits, as well as in caves, where these last happen to occur. In northern Asia, and in America, the only boundary between the northern and temperate zoological provinces is that constituted by the fluctuating annual temperature, and there are no great hilly barriers running east and west, to prevent free migration to the north or south. If reference be made to the map, Fig. 126, it will be seen that these conditions were amply satisfied in the pleistocene age. There were no physical barriers to migration, from the shores of the Mediterranean, as far north as Ireland. If the winter cold were severe, the reindeer and musk-sheep might advance as far south as the Pyrenees, and if the summer heat were intense there would be nothing to forbid the hippopotamus and the African carnivores advancing northwards. It seems to me that this is the only hypothesis which will satisfy all the facts of the case. The traces of glaciers and snow-fields where they are no longer found prove that the winter was severe; while the warmth of the summer seems to be sufficiently demonstrated by the presence of African species. Such extremes of temperature are presented, more or less, by all continents extending from high to low latitudes. They are modified in Europe at the present time by the warm current of the Gulf Stream, by the large area now occupied by the Mediterranean Sea, and by the submergence of the pleistocene lowlands on the Atlantic border.

The Temperate Group.

The third group of pleistocene mammalia consists of those still living in the temperate zones of Europe, Asia, and America :

Beaver.	Wolf.
Hare.	Fox.
Rabbit.	Horse.
Wild Cat.	Urus.
Martin.	Bison.
Stoat.	*Antelope saiga.*
Weasel.	Wild Boar.
Otter.	Stag.
Brown Bear.	Roe.
Grizzly Bear.	

The range of many of these animals has been profoundly modified since the pleistocene age. The *Antelope saiga* of the Don and Volga lived as far to the west as Aquitaine. The grizzly bear, instead of being restricted to its American habitat in the Rocky Mountains, ranged over the whole of Siberia into Europe, as far to the south as the Mediterranean, and westwards as far as Gibraltar.

The urus [1] still lives in the larger domestic cattle, and the bison is represented in Europe by those which are protected by the forest laws of Lithuania, and in North America by the vast herds which are rapidly being exterminated, like the red Indian, by the rifles of the settlers. The horse was as abundant, and as widely spread over Europe, as the urus and the bison ; according to Prof. Brandt it now no longer lives in Siberia in a wild state.

[1] "Quart. Geol. Journ." xxii. 391.

Species common to Cold and Tropical Climates.

The panther or leopard, which has been found alike in Britain, France, and Germany, has at the present day a most extended range through Africa, from Barbary to the Cape of Good Hope, and throughout Persia into Siberia. In this latter country Dr. Gothelf Fischer describes it as living in the same districts in the Altai Mountains, and in Soongaria, as the tiger. The fox and wolf are like instances of carnivores being able to endure great variations in temperature without being specifically modified. These three animals, therefore, tell us nothing as to the pleistocene climate.

Extinct Species.

The extinct pleistocene species may also be divided into the same classes as the living, by an appeal to their geographical distribution. Two out of the three species of rhinoceros found in the caves (*R. megarhinus* and *R. hemitœchus*), and an elephant with slightly curved tusks (*E. antiquus*), had their head-quarters south of the Alps and Pyrenees, whence they wandered northward as far as the latitude of Yorkshire. The pigmy elephant and the dwarf hippopotamus are peculiar to the south, and the *Machairodus latidens*, or large sabre-toothed felis, is a survival, from the pleiocene age, of a peculiarly southern type.

The woolly rhinoceros, on the other hand, may be viewed as a northern form, since it is met with in vast abundance in the arctic regions of Siberia, as well as in Europe, and has not been found south of the Alps and

Pyrenees. The cave-bear has not been discovered either in the extreme north or in the south of Europe, and may therefore be considered of temperate range; and the Irish elk, identified by Prof. Brandt, from the caves of the Altai Mountains, had a similar range in middle Europe. The mammoth, endowed with an elastic constitution, was able to endure the severity of an arctic climate in Siberia and North America, and the temperature of the latitude of Rome and the Gulf of Mexico,[1] and consequently tells us as little of the pleistocene climate as the panther, fox, or wolf.

The evidence, therefore, as to climate, offered by the extinct animals in the caves is of the same nature as that of the living. There is the same mixture of northern and southern forms, which can only be accounted for satisfactorily by seasonal migrations, according to the summer heat and winter cold, such as those which are now observed to take place in Siberia and North America.

Before we consider the relation of the pleistocene animals buried in the caves and river deposits to the glacial period, it is necessary to define what is meant by the term glacial.

Two Periods of Glaciation in Britain.

At the close of the pleistocene period the climate gradually became colder, until ultimately it was arctic in severity in northern Europe. The researches of many eminent observers prove that an enormous sheet of ice, like that under which Greenland now lies buried, extended over North Britain, Wales, and Ireland, leaving

[1] See Falconer, "Palæont. Mem."

its mark in the far-travelled blocks of stone, the moraines, and the grooves which pass over the surface irrespective of the minor contours. The land then, most probably, as Prof. Ramsay and Sir Charles Lyell believe, stood higher than it does now. To this succeeded a period of depression, during which the mountains of Wales were submerged to a height of at least 1,300 feet; and the waves of the sea washed out of the pre-existing glacial detritus the shingle and sand, termed the "middle drift," which occurs also in Scotland and Ireland.[1] Then the land was re-elevated above the waves, and a second period of glaciers set in, traces of which occur abundantly in Wales, Scotland, and Ireland, in the white areas in Fig. 126. They were, however, of far less extent than those which preceded them, occupying isolated areas instead of forming one continuous icy covering to the country. The glacial phenomena may be briefly summed up as follows: 1. As the pleiocene temperature was lowered, the glaciers crept down from the tops of the mountains, until at last they united to form one continuous ice sheet, moving resistlessly over the smaller hills and valleys to the lower grounds, and the first ice or glacial period set in. 2. Then followed the era of depression beneath the sea. 3. And, lastly, on the land re-emerging from the sea the second ice or glacial period began. The climate during the marine depression must obviously have been milder than that of either of the glacial periods, because of the moderating effect of the wide extent of sea.

[1] I have to acknowledge the kind assistance of Professors Hull and Harkness, Mr. Kinahan, and the Rev. H. M. Close, in correlating the Irish with the English glacial deposits. The reader will find the glacial period most ably treated in Lyell's "Antiquity of Man."

The exact relation of the boulder clays with marine shells, in the centre and south of Britain, to the detritus left behind by the ice-sheet in the north, has not as yet been satisfactorily ascertained. It is very probable that the elevation of land in the north was simultaneous with a southern depression, which allowed of icebergs depositing their burdens in the eastern counties, in the valley of the Thames, and as far south as Selsea, on the coast of Sussex.

Three Climatal Changes represented on the Continent.

These changes of climate have also been observed on the continent of Europe. The Swiss geologists have shown that the Alpine glaciers extended farther than they do at the present time, and that they present two stages of extension, the first of which is of greater magnitude than the second. The Alpine blocks and moraines have been traced far down into the plains of Lombardy, northwards into the valley of the Rhine, and in France as far south in the valley of the Rhone as Valence. The admirable essay and map brought by MM. Falsan and Chantre, before the meeting of the French Association for the Advancement of Science at Lyons, in 1873, show that there were two periods of glaciation in the valley of the Rhone, the one being due to the movement of an ice-sheet irrespective of the lower hills, the other being merely the work of the glaciers localized in the valleys. These in all probability correspond in point of time with the like stages of the complicated glacial phenomena in Britain. At this time the glaciers of the Pyrenees, now so small, extended at least from thirty to forty miles from their present posi-

tion down into the plains, leaving behind most astounding evidences of their presence in the valley of the Garonne and elsewhere. On the Spanish frontier, for example, one of the precipitous sides of the valley, near the Pont du Roy, is so smoothed and polished that it is bare of vegetation except in the deep grooves, which offer a precarious support to the roots of ferns and of dwarf beeches. The hills of Dauphiny also and Auvergne were crowned with glaciers, and those of the latter have been shown by MM. Falsan and Chantre to have been conterminous with those of the Alps.

The interglacial period of marine depression in Britain is represented in Switzerland by the lignite beds of Dürnten, Utznach, and Pfaffikon, the last of which rests upon and is covered by the boulder drift. The fossil remains from Dürnten, identified by Dr. Falconer and Prof. Rütimeyer, prove that two southern animals, *Elephas antiquus* and *Rhinoceros megarhinus*, inhabited the district in the interval between the retreat of one set of glaciers and the advance of another. They probably migrated from the plains of Lombardy, where they abounded in the pleistocene age.

Europe invaded by Pleistocene Mammals before the Glacial Period.

What is the precise relation of the pleistocene mammals to these two periods of cold? Did they invade northern and central Europe during the first or the second, before or after, the marine submergence indicated by the "middle drift?" We might expect, *à priori*, that as the temperature became lowered, the northern mammalia would gradually invade the region occupied

before by the pleiocene forms, and that the reindeer, the mammoth, and woolly rhinoceros would gradually supplant the southern *Rhinoceros Etruscus* and *Elephas meridionalis.* Traces of such an occupation would necessarily be very rare, since they would be exposed to the grinding action both of the advancing glacial sheet, and subsequently to that of the waves on the littoral zone during the depression and re-elevation of the land. At the time also that the greater part of Great Britain was buried under an ice-sheet, it could not have been occupied by animals, although they may have been, and most probably were, living in the districts farther to the south, which were not covered by ice. The labours, however, of Dr. Bryce, Prof. Archibald Geikie, and others prove that one at least of the characteristic pleistocene mammalia—the mammoth—lived in Scotland along with the reindeer before the deposit of the lower boulder-clay; while Mr. Jamieson has pointed out that it could not have occupied that area at the same time as the ice, and therefore must be referred to a still earlier date.[1] The teeth and bones discovered in the ancient land surface at Selsea, under the boulder drift, also very probably indicate that the mammoth lived in Sussex before the glacial submergence, although they were never admitted by Dr. Falconer to be of the same age as the remains of *Elephas antiquus* from the same preglacial horizon. The animal also occurs in the preglacial forest-bed of Norfolk and Suffolk. On a careful examination of the whole evidence, I am compelled to believe, with Mr. Godwin-Austen and Prof. Phillips, that the *à priori* belief that the pleistocene mammalia occupied Great Britain before the period of the ice-sheet

[1] "Quart. Geol. Journ." xxi. 161.

and submergence is fully borne out by the few incontestable proofs that have been brought forward of the remains being found in preglacial deposits. And the scanty evidence on the point is just what might be expected from the rare accidents under which the bones in superficial deposits could have withstood the grinding of the ice-sheet, and the subsequent erosive action of the waves on the coast-line. It may therefore be concluded, that the pleistocene mammalia arrived in Europe before the temperature had reached its minimum in the glacial period. On the other hand, the occurrence of mammaliferous river strata, either in hollows of the boulder-clay as at Hoxne, or in valleys excavated after its deposition as at Bedford, prove that the characteristic animals occupied Britain after the retreat of the ice-sheet, and after the re-emergence of the land from beneath the glacial sea.

Mammalia lived in Britain during the Second Ice or Glacial Period.

The distribution of the animals in the river deposits gives us a clue to the physical geography during the second ice period. In an essay read before the Geological Society in 1869, and in a second printed in the "Popular Science Review" in 1872, I showed that there was a singular irregularity in the contents of the river strata, and that while the fossil mammalia were abundant throughout the area (marked with dots in the map, Fig. 126), there were certain districts in which they had not been met with. One of these barren areas comprises (plain in the map, Fig. 126), nearly the whole of Wales. A second includes a large portion of

Lancashire, Yorkshire, Cumberland, Westmoreland, and the whole of Scotland (if the preglacial mammals in the low district between the Frith of Forth and Frith of Clyde in the map be omitted), and a third is represented by nearly the whole of Ireland. These areas are remarkable for the absence of the mammalia from the river deposits. They are also characterised by the freshness of the ice marks which they present. Nearly every valley has its own system of grooves and its own set of moraines; and the mounds of clay and marl left behind by the local glacier, as it slowly retreated to higher levels till it finally disappeared, are to be observed in great abundance. If we bring these facts into relation, the barrenness of the areas may be reasonably explained by the presence of glaciers, *while* the pleistocene mammals were living in the south and east (see map, Fig. 126). A barrier of some kind may reasonably be inferred to have prevented their range over those districts, and its nature is indicated by the ice marks. It is very probable that these glaciers had not passed away before the close of the pleistocene age: for in that case the characteristic animals would be discovered in the river gravels, which are later than the deposits of local glaciers in those districts.

The Glacial Period does not separate one Life-era from another.

The lowering of the temperature which culminated in the glacial period has left palpable traces behind in the changes which it caused in the European fauna. As the pleiocene climate became colder, the animals unfitted to endure the cold, such as the deer of the Indian types of

Axis and Rusa, either migrated to the south or became extinct, while their feeding-grounds were invaded by the dwellers in the temperate zone, the stag, roe, bison, and other animals. These in their turn were pushed forward by the arctic group of animals, the musk-sheep, lemming, reindeer, and others, the progress being in the main steadily to the south while the cold was increasing, and the retreat being steadily to the north while it was decreasing. It will follow from this, that the same district in central or north-western Europe would be traversed by these migratory bodies of animals, both in their southern advance in preglacial and glacial times and their northern retreat in postglacial times, and that, therefore, their fossil remains cannot afford a means of fixing the preglacial, glacial, or postglacial, age of the deposit in which they are found, where it is not marked by traces of glaciation. Sir Charles Lyell's view, that the glacial period cannot be taken as a landmark in the classification of the European pleistocene deposits, is fully borne out by the facts, and still less can it be taken as a hard and fast line between one fauna and another. It cannot be considered a life-era like the eocene, meiocene, pleiocene, or prehistoric divisions of the tertiary period.

Bone-caves inhabited before and after Ice Period.

If we allow that the lowering of the temperature was the principal cause of the presence of temperate and arctic animals, in a region before inhabited by species fitted to live in a comparatively warm climate, it will follow that bone-caves cannot be said to be either pre- or postglacial, by an appeal to their fossil mammalia. If

they were open before the minimum of temperature was reached, they would afford shelter to the animals then in the neighbourhood, and they would continue to be occupied in the south during the vast period of time represented by the enormous physical changes in the region north of the line of the Thames, during the development of the ice-sheet, the submergence and the re-elevation of nearly the whole of Britain and Ireland. As, however, the cold increased, the percentage of arctic animals would also increase, and the more temperate species be weeded out. For these reasons it has seemed to me, that the machairodus of Kent's Hole, and the *Rhinoceros megarhinus* of Oreston, represent an early stage of the pleistocene period, before the arctic mammalia were present in full force in the caves. It is very probable that vast herds of reindeer lived in the south of France, while northern Britain lay buried under the ice-sheet, as well as during the two succeeding physical changes.

Relation of Palæolithic Man to Glacial Period.

What then is the relation of the palæolithic hunter of reindeer in France and Britain to the glacial period? Is he pre- or postglacial? The only evidence on the point is that offered by the associated mammalia which occupied France, Germany, and Britain before and after the point of minimum temperature was reached in these latitudes. Man may have inhabited the caves not merely of France, but of Devonshire and Somerset, at any time during that long period. The position of the palæolithic refuse-heap discovered by Prof. Fraas at

Schussenreid, resting on a moraine of the extinct glacier of the Rhine, proves that the palæolithic Eskimos lived in Suabia after the retreat of the glacier when the temperature became warmer, towards the close of the pleistocene age or in the later glacial stage. The same conclusion has been arrived at by Mr. Prestwich as to the sojourn of palæolithic man (of the river-bed type) in Bedfordshire and Suffolk, the gravels in which the implements are found being of a later age than the boulder-clay of those districts. We have therefore proof that man lived in Germany and Britain after the maximum glacial cold had passed away, and we may also infer with a high degree of probability that he migrated into Europe along with the pleistocene mammalia in the preglacial age.

Test of age of contents of caves in Glaciated Districts.

The probable date of the introduction of the contents into ossiferous caves in glaciated areas may be ascertained by an examination of the river deposits. If the animals found in the caves inhabited the surrounding country after the melting of the ice, their remains will occur in the postglacial gravels. If they are not found, it may be inferred that they had retreated from the district, before the latter were deposited. It is obvious that they could not have lived in any district while it was covered with ice or by the sea. It may therefore be concluded that their remains in the caves were most probably introduced before the glacial conditions had set in. Preglacial deposits in a cavern would be protected from the grinding of the ice-sheet, the action of

the waves in the depression, and re-elevation of the land, and the subsequent glacial erosion which would inevitably destroy nearly all the fluviatile ossiferous strata. By this test the pleistocene strata in the Victoria Cave, near Settle, may be considered preglacial, as well as the hyæna-den at Kirkdale, which has always been referred by Prof. Phillips to that age. If this be allowed, the small fragment of human bone found by the Settle Cave Exploration Committee in the former cave in 1872 establishes the fact that man lived in Yorkshire before the glacial period. The man to whom it belonged was probably devoured by the hyænas which dragged into their den the woolly rhinoceros, reindeer, and other creatures whose gnawed bones were strewn on the floors.

CHAPTER XII.

CONCLUSION.

Classification of Pleistocene Strata by means of the Mammalia.—The late, middle, and early Pleistocene Divisions.—The Pleiocene Mammalia.—Summary of characteristic Pleiocene and Pleistocene Species.—Antiquity of Man in Europe.—Man lived in India in Pleistocene Age.—Are the Palæolithic Aborigines of India related to those of Europe?—Palæolithic Man lived in Palestine.—Conclusion.

The animals inhabiting the caves have been enumerated in the last three chapters, and we have discussed the inferences drawn from their distribution as to the pleistocene climate and geography of Europe. It remains for us now, in conclusion, to define the pleistocene, and to see in what relation it stands to the pleiocene period.

Classification of Pleistocene Strata by means of the Mammalia.

The pleistocene period was one of very long duration, and embraced changes of great magnitude in the geography of Europe, as we have seen in the ninth and tenth chapters. The climate, which in the preceding pleiocene age had been temperate in northern and middle Europe, at the beginning of the pleistocene gradually passed into the extreme arctic severity of the glacial

period. This change caused a corresponding change of the forms of animal life; the pleiocene species, whose constitutions were adjusted to temperate or hot climates, yielding place to those which were better adapted to the new conditions. And since there is reason for the belief that it was not continuous in one direction, but that there were pauses or even reversions towards the old temperate state, it follows that the two groups of animals would at times overlap, and their remains be intermingled with each other. The frontiers also of each of the geographical provinces must naturally have varied with the season; and the competition for the same feeding-grounds between the invading and retreating forms must have been long, fluctuating, and severe. The passage, therefore, from the pleiocene to the pleistocene fauna might be expected to have been extremely gradual in each area. The lines of definition between the two are to a great extent arbitrary, instead of being marked with sufficient strength to constitute a barrier between the tertiary and post-tertiary groups of life of Lyell, or between the tertiary and quaternary of French geologists. The principle of classification which I have proposed [1] is that offered by the gradual lowering of the temperature, which has left its mark in the advent of animals before unknown in Europe; and according to it I have divided the pleistocene deposits into three groups.

1. Those in which the pleistocene immigrants had begun to disturb the pleiocene mammalia, but had not yet supplanted the more southern animals. No arctic mammalia had as yet arrived. To this group belongs the forest-bed of Norfolk and Suffolk, and the deposit at St. Prest, near Chartres.

[1] "Quart. Geol. Journ." 1872, p. 410.

2. That in which the characteristic pleiocene deer had disappeared. The even-toed ruminants are principally represented by the stag, the Irish elk, the roe, bison, and urus. *Elephas meridionalis* and *Rhinocerus etruscus* had retreated to the south. To this group belong the brick-earths of the lower valley of the Thames, the river-deposit at Clacton, the cave of Baume in the Jura, and a river-deposit in Auvergne.

3. The third division is that in which the true arctic mammalia were among the chief inhabitants of the region; and to it belong most of the ossiferous caves and river-deposits in middle and northern Europe.

These three do not correspond with the preglacial, glacial, and postglacial divisions of the pleistocene strata, in central and north Britain; since there is reason to believe that all the animals which occupied Britain after the maximum cold had passed away, had arrived here in their southern advance before that maximum cold had been reached; or, in other words, were both pre- and postglacial.

This classification does not apply to pleistocene river-strata south of the Alps and Pyrenees, into which the arctic mammalia never penetrated.

The Late Pleistocene Division.

The late pleistocene division corresponds in part with the reindeer period of M. Lartet; but it comprehends also his other three periods; for the spotted hyæna, the lion, the cave-bear, the mammoth, the woolly rhinoceros, the bison, the reindeer, and the urus are so associated together in the caves and river deposits of Great Britain and the continent that they do not afford a means of

classification. The arctic division of the mammalia, defined in the preceding chapter, was then in full possession of the area north of the Alps and Pyrenees, and the *Rhinoceros megarhinus* and *Elephas meridionalis* had disappeared. With three exceptions, to be noticed presently, all the ossiferous caverns of France, Germany, and Britain, belong to this division of the pleistocene.

The Middle Pleistocene Division.

The middle division of the pleistocene mammalia may now be examined, or that from which the characteristic pleiocene deer had vanished, and were replaced by the invading forms from the temperate zones of northern Asia. It is represented in Britain by the mammalia obtained from the lower brick-earths of the Thames valley, at Crayford, Erith, Ilford, and Gray's Thurrock, by those from the deposit at Clacton, and most probably by those of the older deposit in Kent's Hole, and by the *Rhinoceros megarhinus* of Oreston.[1] They consist of—

Man, *Homo.*
Lion, *Felis leo spelæa.*
Wild Cat, *F. catus.*
Spotted Hyæna, *Hyæna crocuta var. spelæa.*
Grizzly Bear, *Ursus ferox.*
Brown Bear, *U. arctos.*
Wolf, *Canis lupus.*
Fox, *C. vulpes.*
Otter, *Lutra vulgaris.*
Urus, *Bos primigenius.*
Bison, *Bison priscus.*
Irish Elk, *Cervus megaceros.*
Stag, *C. elaphus.*
Brown's Fallow Deer *C. Browni.*
Roedeer, *C. capreolus.*
Musk Sheep, *Ovibos moschatus.*
Elephas antiquus.
Mammoth, *E. primigenius.*
Horse, *Equus caballus.*
Woolly Rhinoceros, *Rhinoceros tichorhinus.*
R. hemitœchus.
R. megarhinus.
Wild-boar, *Sus scrofa.*
Hippopotamus, *Hippopotamus amphibius.*
Beaver, *Castor fiber.*
Water-Rat, *Arvicola amphibia.*

1 "Quart. Geol. Journ." xx. p. 457.

The discovery of a flint-flake in the undisturbed lower brick-earths of Crayford, by the Rev. O. Fisher, in the presence of the writer, in April 1872, proves that man was living while these fluviatile strata were being deposited.

If these mammalia be compared with those of the forest-bed or the pleiocene age on the one hand, and with the late pleistocene on the other, it will be seen that they are linked to the former by *Rhinoceros megarhinus*, and to the latter by the musk sheep. The presence of the latter, the most arctic of the herbivores, in such strange company is most abnormal, and suggests the idea that the remains belong to two distinct eras. The skull, however, which I found at Crayford in 1867, and presented to the Museum of the Geological Survey, rested in intimate association with the bones of other species, is in the same mineral state, and bears no marks of being a "derived fossil." It is the only trace of the animal as yet obtained from the lower brick-earths.

The absence of the reindeer, so numerous in the valley of the Thames, while the late pleistocene strata were being accumulated by the river, and the abundance of remains of the stag, seem to me to point backwards rather than forwards in time, and to imply that the lower brick-earths are not of late pleistocene age; just as the absence of the characteristic early pleistocene species shows that they are not of that age. The evidence seems to be sufficient to establish a stage intermediate between the two. Nevertheless, it is sufficiently conflicting to cause Dr. Falconer to come to the conclusion that these strata are of pleiocene date, and Mr. Prestwich to believe that they belong to a late stage in the pleistocene.

During the middle pleistocene, in the Thames valley, and at Clacton, the woolly rhinoceros, elephant, and mammoth competed for the same feeding-grounds with *Rhinoceros hemitœchus, R. megarhinus*, hippopotamus, and *Elephas antiquus*. Although all the characteristic pleiocene deer had retreated, the reindeer had not yet invaded that area: it was occupied by the stag, roe, the Irish elk, and Brown's fallow deer. The whole assemblage of animals, the musk sheep being excepted, implies that the climate was less severe at this time, than when the reindeer spread over the same area in the late pleistocene age, and was far more numerous than the stag. It may, indeed, be objected that the classificatory value of the musk sheep is quite as great as that of *Rhinoceros megarhinus*; but in the case of the lower brick-earths, the evidence of the latter as to climate agrees with that of the whole assemblage of animals, while that of the former is altogether discordant.

There are no caves either in Britain or on the continent which can be referred with certainty to this middle division. The machairodus, however, of Kent's Hole, and of the cavern of Baume in the Jura (see p. 337), and the megarhine species of rhinoceros from the fissures of Oreston, probably inhabited those regions, while the temperate group of animals held possession of the valley of the Thames, and of that now sunk beneath the North Sea.

The Early Pleistocene Mammalia.

The fossil mammalia must now be examined, which inhabited Great Britain during the early pleistocene period, and before the maximum severity of glacial cold had as yet been reached. The fossil bones from the

forest-bed, which underlies the boulder-clay on the shores of Norfolk and Suffolk, have for many years attracted the attention of naturalists and geologists. The magnificent collections of the Rev. John Gunn, and the late Rev. S. W. King, gave Dr. Falconer the means of proving that the fauna of the ancient submerged forest differed from that of any geological period which we have hitherto discussed: and the careful diagnosis of all the fossils from this horizon which I have been able to meet with, shows that it was of a very peculiar character, being closely allied to the pleiocene of the south of France and of Italy, and yet possessing species which are undoubtedly pleistocene. The following list is necessarily very imperfect, since the fragmentary nature of the fossils renders a specific identification very hazardous; and it only includes those which I have been able to identify with any degree of certainty.

Sorex moschatus.
S. vulgaris.
Talpa Europæa.
Trogontherium Cuvieri.
Castor fiber.
Ursus spelæus.
U. arvernensis.
Canis lupus.
C. vulpes.
Machairodus.
Cervus megaceros.
C. capreolus.
C. elaphus.
Cervus Polignacus.
C. carnutorum.
C. verticornis.
C. Sedgwickii.
Bos primigenius.
Hippopotamus major.
Sus scrofa.
Equus caballus.
Rhinoceros etruscus.
R. megarhinus.
Elephas meridionalis.
E. antiquus.
E. primigenius.

From the examination of this list, the peculiar mixture of pleiocene and pleistocene species is evident. The *Ursus arvernensis, Cervus Polignacus, Hippopotamus major, Rhinoceros etruscus,* and *R. megarhinus,* the horse,

Elephas meridionalis, and *E. antiquus* were living in the pleiocene age in France and Italy, and probably in Norfolk. The cave-bear, the wolf, fox, mole, beaver, Irish elk, roe, stag, urus, wild-boar, and the mammoth have not as yet been discovered in the continental pleiocenes, as judged by the standards offered by the Val d'Arno and Southern France. They are more or less abundant in the late pleistocene age. This singular association seems to me to imply that the fauna of the forest-bed is intermediate between the two, and, from the fact that only three out of the whole series, viz. *Ursus arvernensis*, *Rhinoceros etruscus*, and *Cervus Polignacus*, are peculiar to the continental pleiocene, that it is more closely allied to the pleistocene than to the pleiocene.

It is also very probable that this early pleistocene age was of considerable duration; for in it we find at least two forms (and the number will probably be very largely increased) which are unknown in continental Europe, although pleiocene and pleistocene strata have been diligently examined in France and Germany. The very presence of the *Cervus Sedgwickii* and *C. verticornis* implies that the lapse of time was sufficiently great to allow of the evolution of forms of animal life hitherto unknown, and which disappeared before the middle and late pleistocene stages. The *Trogontherium* also, as well as the *Cervus carnutorum*, both of which occur in the forest-bed and in the gravel-beds of St. Prest, near Chartres, and which are peculiar to this horizon, point to the same conclusion.

The deer of the forest-bed, in this list, do not represent approximately the number of species: there are at least five, and perhaps six, represented by a series of antlers, which I do not venture to quote, because I have

not been able to compare them with those of the pleiocenes of the Val d'Arno, of Marseilles, or of Auvergne.

Dr. Falconer pointed out that one of the peculiar characters of the fauna of the forest-bed is the presence of the mammoth; and the evidence on which he considered the animal to be of preglacial age in Europe has been fully verified by the molars from Bácton, which are now in the Manchester Museum. They are associated with *Elephas meridionalis* and *E. antiquus*, and are incrusted with precisely the same matrix as the teeth and bones of those species.

No caves have been discovered containing this peculiar assemblage of fossil animals.

The Pleiocene Mammalia.

The relation of the pleistocene to the pleiocene fauna is a question of very great difficulty, because the latter has not yet been satisfactorily defined, although Prof. Gervais and Dr. Falconer have given the more important species from Auvergne, Montpellier, and the Val d'Arno. The following list is taken from Prof. Gervais's great work "Zoologie et Paléontologie Françaises," p. 349, the term pseudo-pleiocene merely implying that the fauna differs from that of the marine deposit of Montpellier, which he takes as his standard.

Pseudo-pleiocene of Issoire.

Hystrix refossa.	*Cervus pardinensis.*
Castor issiodorensis.	*C. arvernensis.*
Arctomys antiqua.	*C. causanus.*
Arvicola robustus.	*Sus arvernensis.*

Lepus Lacosti.	*Ursus arvernensis.*
Mastodon arvernensis.	*Canis borbonidus.*
Tapirus arvernensis.	*Felis pardinensis.*
Rhinoceros elatus ?	*F. arvernensis.*
Bos elatus.	*F. brevirostris.*
Cervus polycladus.	*F. issiodorensis.*
C. ardens.	*Machairodus cultridens.*
C. cladocerus.	*Hyæna arvernensis.*
C. issiodorensis.	*H. Perrieri.*
C. Perrieri.	*Lutra Bravardi.*
C. etueriarum.	

To these animals Dr. Falconer[1] adds *Hippopotamus major*, *Elephas antiquus*, and *Rhinoceros megarhinus*, and he identifies *Rhinoceros elatus* with his new species *Rhinoceros etruscus.* Prof. Gaudry agrees with me in the belief that *Hyæna Perrieri* is identical with *H. striata* or the striped species.

Prof. Gervais also identifies the *Equus robustus* of M. Pomel, from the same locality, with the common Horse, *Equus fossilis.*

The fauna of Montpellier is certainly very different from that of Issoire ; but since it is neither meiocene nor pleistocene, it must belong to one of the intermediate stages of the pleiocene. It includes

Semnopithecus monspessulanus.	*Cervus Cuvieri.*
Macacus priscus.	*C. australis.*
Chalicomys sigmodus.	*Sus provincialis.*
Lagomys loxodus.	*Hyænodon insignis.*
Mastodon brevirostris.	*Hyæna —— ?*
Rhinoceros megarhinus.	*Machairodus.*
Tapirus minor.	*Felis Christolii.*
Antilope Cordieri.	*Lutra affinis.*
A. hastata.	

[1] "Palæont. Mem." vol. ii. p. 49.

The *Mastodon brevirostris* of this list is considered by Dr. Falconer to be identical with *M. arvernensis* of MM. Croiset and Jobert.

The fauna of the Val d'Arno differs from that of Montpellier and of Auvergne, and yet is considered by Dr. Falconer to be eminently typical of the European pleiocene.[1] The animals identified by him in the museums of Italy are as follow :—

Felis.
Hyæna.
Machairodus cultridens.
Mastodon arvernensis.
M. Borsoni.
Elephas antiquus.
Elephas meridionalis.
Rhinoceros etruscus.
R. megarhinus.
R. hemitœchus.
Hippopotamus major.

All these animals, with the exception of *Rhinoceros hemitœchus*, have been discovered in the pseudo-pleiocene of Issoire, while the megarhine rhinoceros and *Mastodon arvernensis* are the only two which have been obtained from the marine sands of Montpellier. The pleiocene animals, therefore, inhabiting Northern Italy are more closely allied to those of Auvergne than to those of Montpellier.

If these three localities be taken as typical of the pleiocene strata, we shall find that several of the species range as far north as Britain, and occur in deposits which from the evidence of the mollusca, have been assigned to that age. *Mastodon arvernensis, Elephas meridionalis,* and *Ursus arvernensis,* have been obtained from the old land-surface which underlies the sand and shingle of the Norfolk Crag, in company with many forms of deer and antelopes which have not yet been identified, while the *Hipparion* is found in the marine crags of Suffolk.

[1] "Palæont. Mem." vol. ii. pp 189, 190.

The animals which especially characterize the pleiocene strata of Europe are *Machairodus cultridens*, *Mastodon arvernensis* and *M. Borsoni*, besides the genus *Tapir*.

If this fauna be compared with that of the preglacial forest-bed, it will be seen that the difference between them is very great. The pleiocene mastodon, tapir, the majority of the deer, and the antelopes are replaced by forms such as the roe and the red-deer, unknown up to that time. Nevertheless many of the pleiocene animals were able to hold their ground against the pleistocene invaders, although, subsequently, as I have already shown, they disappeared one by one, being ultimately beaten in the struggle for life by the new comers. The progress of this struggle has been used in the preceding pages as a means of classification. This fauna has not been discovered in any cave.

Summary of Characteristic Pleistocene and Pleiocene Species.

The following are the salient points of the pleistocene age offered by the study of the land mammalia in the area north of the Alps and Pyrenees.

The Pleistocene Period.

A.—*The latest stage.*

Palæolithic Man.
Woolly Rhinoceros, abundant.
Mammoth, abundant.
Reindeer, abundant.
Stag, comparatively rare.
Northern forms of life in full possession of area north of Alps and Pyrenees.

B.—*The middle stage.*

Palæolithic Man.
Machairodus latidens.
Stag, abundant.
Rhinoceros megarhinus, still living.
Woolly Rhinoceros, present.
Northern forms of life present, but not in force.

C.—*The early stage.*

The following are animals peculiar to this stage :—

Trogontherium Cuvieri.
Cerus verticornis.
Cervus Sedgwickii.
C. carnutorum.

The following make their appearance :—The beaver, musk-shrew, cave-bear, roe, stag, Irish elk, urus, and bison, wild-boar, horse, (2), mammoth, wolf, and fox.

The pleiocene *Ursus arvernensis*, *Cervus Polignacus*, *Rhinoceros etruscus*, and *Elephas meridionalis* still living.

THE PLEIOCENE.

Mastodon arvernensis.
M. Borsoni.
Hipparion gracile.
No living species of European Deer.

The three subdivisions of the pleistocene do not apply to the region south of the Alps and Pyrenees, because the northern group of animals did not pass into Spain and Italy. In these two countries we find southern and pleiocene animals living throughout the pleistocene age, which in France and Britain lived only in the two earlier stages.

Antiquity of Man in Europe.

No remains have been discovered up to the present time in any part of Europe which can be referred with certainty to a higher antiquity than the pleistocene age.

The palæolithic people or peoples arrived in Europe along with the peculiar fauna of that age, and after dwelling here for a length of time, which is to be measured by the vast physical and climatal changes, described in the last three chapters, finally disappeared, leaving behind as their representatives the Eskimos tribes of arctic America. There is no evidence that they were inferior in intellectual capacity to many of the lower races of the present time, or more closely linked to the lower animals. The traces which they have left behind tell us nothing as to the truth or falsehood of the doctrine of evolution, for if it be maintained on the one hand, that the first appearance of man as a man, and not as a man-like brute, is inconsistent with that doctrine, it may be answered that the lapse of time between his appearance in the pleistocene age and the present day, is too small to have produced appreciable physical or intellectual change. Also, it must not be forgotten, that we have merely investigated the antiquity of the sojourn of man in Europe, and not the general question of his first appearance on the earth, with which it is very generally confounded. Dr. Falconer well remarked that the *origines* of mankind are to be sought, not in Europe, but in the tropical regions, probably of Asia. To these we have no clue in the present stage of the inquiry. The higher apes are represented in the European meiocene and pleiocene strata, by extinct forms uniting in some cases the characters of different living species, but they do not show any tendency to assume human characters. It must indeed be allowed, that the study of fossil remains throws as little light as the documents of history on the relation of man to the lower animals. The historian commences his labours with the high civili-

sation of Assyria and Egypt, and can merely guess at the steps by which it was achieved; the palæontologist meets with the traces of man in the pleistocene strata, and he too can merely guess at the antecedent steps by which man arrived even at that culture which is implied by the implements. The latter has proved that the antiquity of man is greater than the former had supposed. Neither has contributed anything towards the solution of the problem of his origin.

Man lived in India in Pleistocene Age.

The researches of the Geological Surveyors has shown that in ancient times man, in the same stage of civilization as the palæolithic man of Europe, lived in Southern India and in the valley of the Narbadá. In 1868[1] Mr. Bruce Foote described the flint implements which were discovered over a large area in the districts of Madras, either in the red clayey deposit known as Laterite, or in such positions as implied that they had been washed out of it. They all belong to the same rude types as those of the pleistocene strata of North-western Europe. A small fragment of bone was the only fossil which had up to that time been discovered in the Laterite, and this I was able to identify in 1869 as a portion of a human tibia of the abnormal platycnemic variety, which has been described in the fifth chapter of this work, from the European caves and tombs. The Lateritic deposits themselves are strictly analogous to our river-strata and brick-earths in their consti-

[1] "Quart. Geol. Journ." xxiv. p. 484. "International Congress," Norwich volume. See also "Evans' Ancient Stone Implements," p. 570.

tution, and in their resting at various levels above the sea, and were, as Mr. Foote remarks, formed under conditions different to those which are now going on in that district. They prove that the period of the sojourn of palæolithic man in Southern India is divided from the present day by considerable geographical changes, such as the elevation of land, and the erosion and breaking up of accumulations which were once continuous. We have seen that somewhat similar changes have happened in Europe, in the interval which separates the palæolithic period from our own time.

The discovery of a rudely chipped implement of quartzite, of the pointed oval shape common in the gravels of Britain and France, published by Mr. Medlicott in 1873, in the "Records of the Geological Survey of India," proves further that man was a member of the remarkable fauna which inhabited the valley of the Narbadá in ancient times. It was dug out of reddish unstratified clay by Mr. Hacket at a depth of three feet from the upper surface, which was covered by twenty feet of ossiferous gravel, on the left bank of the Narbadá near the valley of Bhutra. The clay belongs to the same fluviatile series as that from which the mammalia were obtained and named by Dr. Falconer in 1828. Both clay and gravel are shown to be of fluviatile origin, by the presence of fresh-water mussels of the varieties still living in the adjacent river.

The fossil bones belong to extinct and living animals. Among the former are two kinds of elephant (*E. namadicus*) and (*E. stegodon insignis*), one of which is closely allied to the European *E. antiquus*, two species of hippopotamus, one (*H. palæindicus*) with four incisors in front of the jaws like the African, and a second with six incisors

belonging to the extinct division of hexaprotodon, a large ox (*Bos namadicus*), a deer and a bear. The living forms are represented by the buffalo (*Bubalus namadicus*), which is identical with the wild arnee from which the Indian domestic buffaloes have descended, and the gavial, or long-snouted Gangetic crocodile. This imperfect list, borrowed from Dr. Falconer,[1] shows that there is the same mixture of extinct with living forms in the valley of the Ganges, while the clays and gravels were being accumulated, as we have observed in the pleistocene deposits of Europe, and the fauna may therefore be referred to the pleistocene age, and probably, as Mr. Medlicott proposes, to the late division of that age. The exact correspondence of the quartzite implements with those which are so abundant in the European river-strata of the same age, adds additional weight to this conclusion.

Are the Palæolithic Aborigines of India related to those of Europe?

It is not a little remarkable that Dr. Falconer, writing in 1865 of the peculiar fauna of the Narbadá, should have held the view that man was living in India at that time, and that the memory of the hippopotamus was handed down in Aryan traditions, under the striking name of the water elephant. "After reflecting," he writes, "on the question during many years in its palæontological and ethnological bearings, my leaning is to the view that *Hippopotamus namadicus* was extinct in India long before the Aryan invasion, but that it was

[1] "Palæont. Mem." ii. 642, *et passim*.

familiar to the earlier indigenous races." (ii. p. 644.) This inference is proved to be literally true by the discovery of the palæolithic implements in the ossiferous strata of the Narbadá, which must have required long ages for their accumulation and subsequent erosion.

We may, therefore, conclude that palæolithic man inhabited both Europe and India in the pleistocene age. And possibly the identity of the implements, in these two remote regions, may be accounted for in the same manner as the identity of Aryan root-words, by the view that their fabricators may have come from the same centre of dispersal, by the same routes as those which were subsequently used by the pre-Aryan, and Aryan, invaders of Europe and India. But whether this be accepted or not, it cannot be denied that the man who inhabited both these regions was in the same rude stage of human progress, and played his part in the same life-era.

Palæolithic Man lived in Palestine.

The discovery, by the Abbé Richard,[1] of a palæolithic flint implement, of the ordinary river-bed type, on the surface of a stratum of gravel between Mount Tabor and the lake of Tiberias, lends great weight to the view that the Aborigines of India and Europe, whose implements are found in the deposits of rivers, migrated from the same centre, since it bridges over the great interval of space by which they were isolated. It is very probable, that future discoveries may reveal the presence of a tolerably uniform priscan population, in the pleistocene

[1] This implement was exhibited before the Meeting of the British Association at Edinburgh, in 1871.

belonging to the extinct division of hexaprotodon, a large ox (*Bos namadicus*), a deer and a bear. The living forms are represented by the buffalo (*Bubalus namadicus*), which is identical with the wild arnee from which the Indian domestic buffaloes have descended, and the gavial, or long-snouted Gangetic crocodile. This imperfect list, borrowed from Dr. Falconer,[1] shows that there is the same mixture of extinct with living forms in the valley of the Ganges, while the clays and gravels were being accumulated, as we have observed in the pleistocene deposits of Europe, and the fauna may therefore be referred to the pleistocene age, and probably, as Mr. Medlicott proposes, to the late division of that age. The exact correspondence of the quartzite implements with those which are so abundant in the European river-strata of the same age, adds additional weight to this conclusion.

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[1] "Palæont. Mem." ii. 642, *et passim.*

throwing great light on the fragmentary records of those obscure times. In treating of these questions, it has been necessary to discuss problems of deep and varied interest to the ethnologist, physicist, and historian, some of which have been partially solved, while others await the light of the higher knowledge which will be the fruit of a wider experience.

APPENDICES.

APPENDIX I.—P. 30.

ON THE INSTRUMENTS AND METHODS OF CAVE-HUNTING.

Instruments used in Cave-hunting.—The Search after Bone-caves.—The three modes of Cave-digging.—Stalagmitic Floors to be broken up.—Preservation of Fossil Bones.

Instruments used in Cave-hunting.

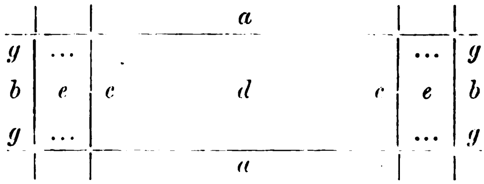
The instruments which Mr. James Parker, Mr. Ayshford Sanford and myself have found most valuable in cave-hunting, apart from the tools of the workman, are as follow :—

1. A hammer with an ash handle about twenty inches long, inserted into a square head of best steel, ending in a chisel edge in the same plane as the handle, weighing almost eight ounces, and seven inches in length.
2. A steel chisel ten inches long.
3. A prismatic compass.
4. A thermometer for taking the temperatures of the air and water.
5. An aneroid.
6. A steel measuring tape.
7. Abney's patent level which is used for laying down datum-line for plan, as well as for taking the dips and angles.

In making a plan we have found it useful to mark the datum-line by a stout string or wire and to measure from it as the work proceeds, indicating on the sides and floor of the cave the points of measurement, with paint or wooden pegs.

8. A stout rope not less than twenty feet long with a horse's girth at the end is necessary for the exploration of vertical fissures, so that the explorer may be let down without any great danger. No large unknown caves should be explored without a rope, or by a party less than three in number. In exploring the caves of Burrington Combe we used a rope sixty feet long. The descent into Helln Pot, described in the second chapter, p. 41, was affected in the following manner. A strong platform of timber was made over the open fissure, and from it a square "cage" or "basket" of the ordinary kind used in mining was let down for the first drop of 198 feet. It was prevented from twisting round by two guide ropes. For the rest of the falls we had two ladders eight feet long, and a rope, without which we should have been unable to reach the bottom.

9. In the exploration of water-caves, in which there are sometimes sheets of water of considerable size and depth, a raft may be used, such as that devised by Mr. James Parker for the navigation of the great cave of Wookey Hole. It consisted of a platform supported on barrels and built as follows: A frame of stout poles was made; two, *a a*, being eight feet long, with four, others, *b*, *c*, lashed firmly across, each four feet in length. The space



d was converted into a platform by nailing boards across, and this was buoyed up by a beer-barrel at each end in the interspace *e*. The barrels were attached to the raft by two loops of rope *g*, passing over from *b* to *c*, and thus kept in place, although they freely twisted and turned in actual use. The ropes had an advantage over iron hoops for the attachment of the barrels, because when they were tightened the platform was raised above the water, when they were loosened it was lowered, and thus the raft could be adjusted to the weight to be carried, to the depth

of the water, and the distance of the water-line from the roof. A raft of this kind will bear three persons, and is sufficiently light to be carried over the shallows. With it Mr. Parker made his way for a considerable distance in the Wookey Hole cavern, and subsequently I penetrated as far as the water-line would allow me to get. A long pole is also necessary for punting. Mr. Parker found by experience that a raft made of boards nailed on the top of two beer-barrels was too unstable to be of any use. In making his way across subterranean pools the cave-hunter ought to be prepared for accidents, for the depth is very uncertain, and the water sufficiently cold to cause cramp. For the exploration of ordinary water-caves a raft is unnecessary, but no attempt should be made without a rope. In Yorkshire and Derbyshire there is an unlimited field for adventure in the subterranean water-courses.

10. The most convenient lights for use in caves are the common composite candles. Paraffin candles are open to the objection that they gutter, lanthorns do not give a sufficiently diffused light, and the smoke of paraffin torches, or flambeaux dipped in turpentine or tar is intolerable. Magnesium wire reveals the beauties of the higher roofs.

The Search after Ossiferous Caves.

Many of the ossiferous caves, and especially those of the neolithic and pleistocene ages, have their entrances masked by débris which has been accumulated from the surface above during the long lapse of ages. In their discovery I have found rabbits, foxes, and badgers of the greatest service, since these animals generally make their burrows in such places. And where their earths are met with at the base of a vertical wall of rock, I have very generally found a cave. They were my sole guides to the discovery of the five sepulchral caves at Perthi Chwareu, described in the fifth chapter, in a district in which up to that time caves were not known to exist.

The dwellers in caves very generally chose for their habitations the sunny side of the ravines and valleys, and the spots

which commanded a wide view, and, therefore, their remains are to be looked for in those places, rather than on the cold and sunless sides, or where an enemy might approach without observation.

The Scientific Methods of Cave-digging.

The exploration of an ossiferous cavern with sufficient accuracy to be of scientific value, may be carried out in all tunnel caves, or those extending horizontally into the rock, by one of the three following methods which may be adapted to the local conditions:—

The first step to take in all cases is to make a plan of the entrance, and to cut a passage down to the rock at the entrance, so as to obtain a clear idea of the sequence of the strata. In the hyæna-den at Wookey Hole, we first of all cut a passage through the cave-earth which extended from the roof to the floor, and then removed the earth on either side in blocks, until ultimately the chamber and passages described in the eighth chapter were cleared of their contents. Our work was measured every evening, and each bone and object found was labelled with the date which was recorded on the ground plan. Vertical sections were also taken from time to time. This mode, supplemented by constant supervision of the workmen, was sufficiently accurate to satisfy the demands of scientific research.

The Victoria Cave, where the demarcation between the strata was very distinct, was explored, while the work was under my direction up to September 1873, in a somewhat similar fashion. It was, however, impossible on account of the great depth of the deposits to cut a passage down to the rock at the entrance. We therefore examined the superficial strata throughout the cave, merely gauging the thickness of those below by sinking three shafts. Where a cave is sufficiently high to allow of the work being carried on, it is better to clear out one stratum before another is disturbed.

The most elaborate and perfect method of cave exploration is that which has been used by the committee in Kent's Hole,

under the superintendence of Mr. Pengelly, who writes as follows :[1]—

" The following is the method of exploration which has been observed from the commencement, and which it is believed affords a simple and correct method of determining the exact position of every object which has been found.

" 1. The black soil accessible between the masses of limestone on the surface was carefully examined and removed.

" 2. The limestone blocks occupying the surface of the deposits were blasted and otherwise broken up, and taken out of the cavern.

" 3. A line termed the 'datum-line,' is stretched horizontally from a fixed point at the entrance to another at the back of the chamber.

" 4. Lines, one foot apart, are drawn at right angles to the datum-line, and therefore parallel to one another, across the chamber so as to divide the surface of the deposit into belts termed 'parallels.'

" 5. In each parallel the black mould which the limestone masses had covered is first examined and removed, and then the stalagmite breccia, so as to lay bare the surface of the cave-earth.

" 6. Horizontal lines, a foot apart, are then drawn from side to side across the vertical face of the section so as to divide the parallel into four layers or 'levels,' each a foot deep.

" Finally each level is divided into lengths called 'yards,' each three feet long, and measured right and left from the datum-line as an axis of abscissæ.

"In fine, the cave-earth is excavated in vertical slices or parallels four feet high, one foot thick, and as long as the chamber is broad, where this breadth does not exceed thirty feet. Each parallel is taken out in levels one foot high, and in each level in horizontal prisms three feet long and a foot square in the section, so that each contains three cubic feet of material."

"This material, after being carefully examined *in situ* by candle-light, is taken to the door and re-examined by daylight, after which it is at once removed without the cavern. A box is ap-

[1] Brit. Ass. Reports, 1865, p. 18.

propriated to each yard exclusively, and in it are placed all the objects of interest which the prism yields. The boxes, each having a label containing the data necessary for defining the situation of its contents, are daily sent to the honorary secretary of the committee, by whom the specimens are at once cleaned and packed in fresh boxes. The labels are numbered and packed with the specimens to which they respectively belong, and a record of the day's work is entered in a diary.

"The same method is followed in the examination of the black mould, and also of the stalagmitic breccia, with the single exception that in these cases the parallels are not divided into levels and yards."

A careful record of the work, and minute sections should be taken daily on the spot.

The Stalagmitic Floor to be broken up.

In all cases the crystalline flooring of stalagmite and stalagmitic breccias which often occur, should be broken up, or, if necessary, blasted with gunpowder. The former very frequently conceals the pleistocene remains, and the latter, which is in Kent's Hole many feet thick, often contains the traces of man and wild animals. Sometimes it is very difficult to distinguish the breccia from the rocky floor.

Where the ossiferous deposit fills a vertical fissure it must be worked on the same plan as in ochre-mining, by sinking a shaft. To dig into it from below (where this is possible) is very dangerous, because of the large imbedded stones which fall sometimes without any warning.

The Preservation of Fossil Remains.

The fossil bones and teeth, which have very generally lost their gelatine and have a tendency to crumble and split to pieces in drying, should be gradually dried, and from time to time saturated with a weak hot solution of gelatine or glue. Silicate of soda, sometimes called "liquid glass," or melted paraffin (not

the oil), may also be used for the same purpose. If the bones are extremely soft, they may be rescued from destruction by letting them dry in the matrix, saturating them and the matrix with a solution of gelatine, and then clearing off the latter. In this manner I preserved the skull of the musk sheep which is now in the Museum of the Geological Survey in Jermyn Street, London.

APPENDIX II.—P. 40.

Observations on the Rate at which Stalagmite is being accumulated in the Ingleborough Cave. Proceed. Lit. and Phil. Soc. Manch. April 1873.

The only attempt to measure with accuracy the rate of the accumulation of stalagmite in caverns, in this country, is that made by Mr. James Farrer in the Ingleborough Cave, in the years 1839 and 1845, and published by Prof. Phillips in the "Rivers, Mountains, and Sea Coast of Yorkshire" (second edition, 1855, pp. 34—35). The stalagmite of which the measurements were taken is that termed, from its shape, the Jockey Cap. It rises from a crystalline pavement to a height of about two and a half feet, and is the result of a deposit of carbonate of lime, brought down by a line of drops that fall into a basin at its top, and flow over the general surface. On March 13th, 1873, in company with Mr. John Birkbeck and Mr. Walker, I was enabled by the kindness of Mr. Farrer to take a set of measurements, to be recorded for use in after years.

For the sake of insuring accuracy in future observations, three holes were bored at the base of the stalagmite, and three gauges of brass wire, gilt, inserted; gauge No. 1 in the following table being that on the S.S.E., No. 2 on N.N.E., No. 3 on the West side. The curvilinear dimensions were taken with fine iron wire, or with a steel measure; and the circumferential around the base along a line marked by the three gauges. The measurements 2,

3, and 4 of the table were taken on the 15th of March, by Mr. Walker, and their accuracy may be tested by the fact that they coincide exactly with No. 1, which I took two days before.

The lengths of wire, properly labelled, are deposited in the Manchester Museum, the Owens College, for future observers.

In the following table I have given my own measurements and compared them with those taken by Mr. Farrer.

TABLE OF MEASUREMENTS.

	13th Mar. 1873. Inches.	1839. Inches.	30 Oct. 1845. Inches.	Increase since 1839.	Increase since 1845.	Rate of Increase per annum. Inches.
1 Basal circumference at Gauges...	128	118	120	10	8	·2941—·2857
2 Gauge No. 1 to Gauge No. 2.......	52·625					
3 ,, 2 ,, 3.......	35·0					
4 ,, 3 ,, 1.......	40·375					
5 Gauge No. 1 to hole in centre of basin at apex	30					
6 ,, 2 ,, ,, ...	29·5					
7 ,, 3 ,, ,, ...	31·4					
8 Height from Gauge No. 1	20·9					
9 ,, ,, 2 min.....	20·4					
10 Maximum	29·7					
11 Tape measurement on slope Gauge No. 1 to edge of apex.	26·7					
12 ,, No. 2 ,, ,,	26·6	21·0		5·6		
13 ,, ,, maximum ,,	36·0	32·0	35·0	4 0	1·0	
14 Roof to apex of Jockey Cap......	87		95·25		8·25	2946
15 Roof to tip of stalactite............			10			
16 Stalactite to apex of Jockey Cap			85·25			

Unfortunately I have been unable to identify the exact spots where the stalagmite was measured by Mr. Farrer, so that the only measurement which affords any trustworthy data for estimating the rate of increase is number 14. With regard to this, the only possible ground of error is the erosion of the general surface of the solid limestone, of which the roof is composed, by carbonic acid, since the year 1845, and this is so small as to be practically inappreciable. We have, therefore, evidence that the Jockey's Cap is growing at the rate of ·2946 of an inch per annum, and that if the present rate of growth be continued it will finally arrive at the roof in about 295 years. But even this comparatively short lapse of time will probably be diminished by the growth of a pendent stalactite above, that is now being formed in place of that which measured ten inches in 1845, and has since been accidentally destroyed. It is very possible that

the Jockey Cap may be the result not of the continuous but of the intermittent drip of water containing a variable quantity of carbonate of lime, and that, therefore, the present rate of growth is not a measure of its past or future condition. Its possible age in 1845 was estimated by Prof. Phillips at 259 years, on the supposition that the grain of carbonate of lime in each pint was deposited. If, however, it grew at its present rate it may be not more than 100 years old. All the stalagmites and stalactites in the Ingleborough Cave may not date further back than the time of Edward III. if the Jockey Cap be taken as a measure of the rate of deposition.

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